FOCUSED FEASIBILITY STUDY
SYRACUSE CHINA LANDFILL
SYRACUSE, NEW YORK

February 1996

Prepared for

Syracuse China Company
P.O. Box 4820
Syracuse, New York 13221-4820

Prepared by

Geraghty & Miller, Inc.
24 Madison Avenue Extension
Albany, New York 12203
(518) 452-7826

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Prepared by GERAGHTY & MILLER, INC.

Kumar Selvakumar
Kumar Selvakumar, P.E.
Senior Engineer

Gregory Shkuda
Gregory Shkuda
Associate/Project Officer

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DISCLOSURE STATEMENT

The laws of New York State require that corporations which render engineering services in New York be owned by individuals licensed to practice engineering in the State. Because Geraghty & Miller, Inc. is a publicly held business corporation, it cannot meet that requirement. Therefore, all engineering services rendered to Syracuse China Company in New York are being performed by GM Consulting Engineers, P.C., a New York professional corporation qualified to render professional engineering services in New York. There is no surcharge or extra expense associated with the rendering of professional services by GM Consulting Engineers, P.C.

Geraghty & Miller, Inc. is performing all those services which do not constitute professional engineering and is providing administrative and personnel support to GM Consulting Engineers, P.C. All matters relating to the administration of the contract with Syracuse China Company are being performed by Geraghty & Miller, Inc. pursuant to its Amended and Restated Services Agreement with GM Consulting Engineers, P.C. All communications should be referred to the designated project manager at Geraghty & Miller, Inc.

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1. INTRODUCTION

Geraghty & Miller, Inc. was retained to conduct a focused remedial investigation/feasibility study (RI/FS) at the Syracuse China Landfill (Site), which is located on the property of the Syracuse China Company (Syracuse China), in Syracuse, New York. The focused feasibility study (FFS) was conducted in accordance with the approved scope of work (Geraghty & Miller, Inc. 1995a) generated for the Site as required by Administrative Order (AO) on Consent No. A601408802 dated November 1, 1994.

This FFS is based on the results of the Remedial Investigation (RI) report (Geraghty & Miller, Inc. 1995b). The final RI was submitted to the New York State Department of Environmental Conservation (NYSDEC) on December 1, 1995 and was approved by the NYSDEC on December 5, 1995. The United States Environmental Agency (USEPA) and NYSDEC have recognized that industrial landfills typically share similar characteristics and have undertaken an initiative to develop presumptive remedies to accelerate cleanup at the sites. The results of the RI disclose that the site exhibits characteristics, typical of industrial landfills, that make a presumptive remedy appropriate. The presumptive remedy approach followed in this FFS is in accordance with the Superfund Accelerated Cleanup Models (SACM)(USEPA 1990).

1.1 PURPOSE

The purpose of this FFS is to devise remedial alternatives to reduce the potential human health and environmental risks associated with the constituents of concern (COCs) identified at the Site and to investigate the feasibility of such alternatives using available information. The purpose of the FFS report is to document the basis and procedures in identifying, developing, screening, and evaluating a range of presumptive remedial alternatives in order to select the most feasible and cost-effective remedial alternatives for the Site.

1.2 SITE BACKGROUND

The Syracuse China Landfill is located to the north of the Syracuse China facility in Syracuse, Onondaga County, New York (Figure 1-1). The landfill occupies an area of approximately 13 acres and is bounded by Conrail railroad tracks on the south side, wetlands on the north side, and undeveloped Syracuse China property on the east and west sides (Figure 1-2).

Current Site topography is dominated by two mounds: the western half of the landfill and the eastern half of the landfill (Figure 1-3). The western portion of the landfill is the oldest part of the landfill and reportedly contains broken china, gypsum molds, facility wastewater treatment sludge, cement, and construction debris. The eastern portion of the landfill reportedly contains broken china, gypsum molds, wastewater treatment sludge, and refractory material (Geraghty & Miller, Inc. 1995b).

Two primary settling ponds and two secondary settling ponds are located between the landfill mounds (Figure 1-3). These ponds were part of the wastewater treatment pond system. Effluent from the facility wastewater treatment was discharged to primary Settling Ponds 1 and 2. Prior to the discharge of the effluent to Settling Pond 1, a flocculant was added to aid the settling out of the suspended solids in the wastewater stream. Periodically, the settling ponds were dredged and the materials were placed in the sludge pond. The material in the sludge pond was allowed to dry before it was placed in the landfill. The ponds have not been dredged since May 1989.

In July 1990, facility modifications were made to the wastewater treatment system. Non-sanitary effluent from the facility combines in a single discharge line prior to a facility sampling point (Site 011). Prior to facility modifications, a coagulant/flocculant was added continuously at Site 011 to the wastewater effluent stream to accelerate the settling process. The discharge line passes under the railroad tracks to an open ditch, which continued to Settling Pond 3. Water then flowed through a culvert to Settling Pond 4, and to Settling Pond 2. Water discharged at a State Pollutant Discharge Elimination System (SPDES) - permitted outfall, sampling point Site 001, located at the north end of Settling Pond 2 (Figure

1-3). Because of improvements to the wastewater quality, the facility is currently not pretreating the wastewater prior to discharge to the ponds.

Syracuse China maintains a SPDES Permit (NY 010-0137) to discharge effluent from its manufacturing facility to Ley Creek through the outfall (Site 001) at the north end of Settling Pond 2. At the same time that wastewater modifications were made in July 1990, Syracuse China incorporated process changes to capture suspended solids prior to discharge to the settling pond. Leaded materials (e.g., glaze and pigments) are currently either recycled in a closed-loop system or are put through a pretreatment system and then discharged to the local publicly operated water treatment facility.

Syracuse China has used the area north of the facility as an industrial landfill since approximately 1940. The general public had access to the landfill until it was fenced, sometime in the late 1960s or early 1970s. Although undocumented, the public reportedly left some refuse materials in the landfill In addition, contractors for the City of Syracuse, and the Towns of Salina and Dewitt disposed of road fill and materials cleared from storm sewer catch basins in the landfill (O'Brien & Gere Engineers, Inc. 1990).

During late 1988, Syracuse China contacted the NYSDEC Region 7 regarding upgrading or closure of the landfill in response to revised regulations governing solid waste management (i.e., 6 New York State Codes, Rules, and Regulations [NYCRR] Part 360). Subsequently, Syracuse China conducted a study of the groundwater quality around the landfill and submitted to NYSDEC a "Preliminary Hydrogeologic Site Assessment Report" (O'Brien & Gere Engineers, Inc. 1990) to the NYSDEC. This report detailed the results of an investigation conducted to characterize the quality of groundwater and surface water in the vicinity of the landfill and the wastewater treatment sludge disposed in the landfill. The analytical data collected as part of the assessment indicated that four wastewater treatment sludge samples, collected in the vicinity of the settling ponds, exceeded the EP Toxicity threshold for lead (5.0 milligrams per liter [mg/L]). Based on these data, the NYSDEC listed the Site on the Registry of Inactive Hazardous Waste Disposal Sites with a classification of 2.

Syracuse China ceased disposal of solid waste in the landfill in September 1994.

1.2.1 Nature and Extent of Findings

Soil, sludge, wetland soil, surface-water, and groundwater samples were collected from the site to characterize the COCs in each media. The samples were analyzed by IEA Laboratories of Monroe, Connecticut, and the results were validated by Geraghty & Miller. The analytical results were included in the RI report (Geraghty & Miller, Inc. 1995b). A summary of the data from the RI is presented below.

1.2.1.1 Groundwater

Groundwater samples were collected and analyzed from eight monitoring wells (MW1 through MW-7, and MW-4I) in January and August 1995. Groundwater sampling locations are shown on Figure 1-3. VOCs or cyanide were not detected above the method quantification limit in the groundwater samples collected. Consistent with 6NYCRR Part 360-2.11(d)(3)(vi)(f), the RI work plan specified the collection of both dissolved (filtered) and total (unfiltered) samples for metals analysis if the turbidity measured at the time of groundwater sampling exceeded 50 nephelometric units (NTUs). Each groundwater sample collected during January and August 1995 had a turbidity greater than 50 NTUs; therefore, both dissolved and total samples were collected from each monitoring well. Since the groundwater samples collected had elevated turbidities, the total (unfiltered) analyses are not representative of dissolved concentrations in groundwater. Consequently, the reported results included both the dissolved and total analyses.

In January 1995, iron, magnesium, manganese, sodium, and zinc were detected above the NYSDEC Technical and Operations Guidance Series (TOGS) 1.1.1; November 1991 Ambient Water Quality Standards and Guidance Values (NYSDEC 1991) for dissolved (filtered) metals. A summary of the dissolved and total metal concentrations that exceeded the standards and guidance values is presented in Tables 1-1, 1-2 and 1-3.

Total (unfiltered) metals samples were also collected in January 1995. As can be expected (i.e., from suspended solids), the total metals samples contained higher concentrations for the five metals listed above, plus detection of four additional metals;

arsenic, copper, lead, and vanadium. However, the lead data reported for the January 1995 sampling of MW-4I were deemed unusable upon data validation. Subsequently, a second round of groundwater sampling was conducted in August 1995, exclusively for inorganic parameters. Again, both filtered and non-filtered samples were collected.

The August 1995 dissolved (filtered) metal analytical results indicate that four metals (iron, magnesium, manganese, and sodium) were detected in excess of their respective NYSDEC TOGS 1.1.1 - Ambient Water Quality Standards and Guidance Values. Nine metals (arsenic, copper, iron, lead, magnesium, manganese, sodium, vanadium and zinc) were detected above drinking water standards in unfiltered samples. However, as discussed above, the unfiltered samples are not representative of dissolved concentrations due to the turbidity of the samples.

1.2.1.2 Soils

Soil samples were collected and analyzed from five landfill borings (Soil Borings SB-1 through SB-5) and four monitoring wells borings (Monitoring Wells PMW-3I, MW-4I, MW-6, and MW-7). The soil sampling locations are shown on Figure 1-3. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), or cyanide were not detected above the method of quantification limit, with the exception of acetone, which was due to laboratory contamination.

Aluminum, calcium, chromium, iron, lead, magnesium, manganese, and zinc were detected in each of the nine samples analyzed. Arsenic (five samples), copper (four samples), nickel (four samples), vanadium (two samples), and barium (one sample) were also detected in the selected soil samples. With the exception of lead, which was detected at a concentration of 426 milligrams per kilogram (mg/kg) in Sample SB-3, the concentrations of metals detected are within the range of the recommended soil cleanup objectives and/or eastern United States background concentrations for metals in the NYSDEC Technical Assistance Guidance Memorandum (TAGM), HWR-94-4046 (NYSDEC 1994) (Specifically, the concentration of chromium in one sample was above the recommended clean-up criterion but was below the eastern United States background concentration. Zinc was detected at the recommended soil clean-up criterion.) Average lead concentrations in urban/suburban areas or near highways typically range from 200 to 500 mg/kg (NYSDEC 1994).

Wetland soil samples were collected on two occasions during the RI. Eight wetland soil samples (SS-5 through SS-12), and two landfill berm samples (BM-1 and BM-2) were collected and analyzed for VOCs and inorganics in December 1994. Wetland soil and landfill berm sampling locations are shown on Figure 1-3. Five VOCs were detected at estimated concentrations ranging from 3 to 36 ug/kg. These concentrations were below the respective method quantitation limit.

Additional soil samples were collected within the wetland and were analyzed for heavy metals. The results of the analyses of the two (12/94 and 8/95) sets of samples indicated that eight metals were measured in wetland soils at levels of potential concern. Concentrations of these metals ranged from non-detect up to the values included in the parenthesis below. These metals are: arsenic (44.3 mg/kg), chromium (32.1 mg/kg), copper (154 mg/kg - estimated value), lead (6,010 mg/kg), mercury (1.1 mg/kg), nickel (39.4 mg/kg), silver (35 mg/kg), and zinc (796 mg/kg - estimated value). Lead was the most widespread heavy metal measured and also the heavy metal which was measured at the highest concentration.

1.2.1.3 Settling Ponds

As part of the collection of wetland soil samples, samples were also collected from each of the settling ponds (SS-7, SS-8, SS-9, SS-10 and SS-11). Elevated concentrations of lead and other metals were detected in each of the samples and will be addressed as part of the proposed remedial action.

1.2.1.4 Surface Water

Seven surface-water samples (SW-5 through SW-10, and SW-12) were collected and analyzed. Surface-water sampling locations are shown on Figure 1-3. VOCs were not detected above the method quantification limit, with the exception of chloroform, which was detected at a concentration of 10 micrograms per liter (ug/L) in the surface-water sample SW-10. Chloroform is commonly found in treated water supplies and probably does not reflect site contamination. Lead and zinc were detected in excess of NYSDEC surface-water standards. Zinc was detected above the surface-water standard of 0.03 (mg/L) based on protection of aquatic life. The surface-water standard for lead was calculated to be 0.0064 mg/L based on a water hardness of 200 mg/L. The highest lead concentration (0.048 mg/L) was detected at SW-12, near the SPDES outfall. The highest zinc concentration (122 mg/L) was detected in sample SW-8 from Pond 2.

1.2.1.5 Air

When soil borings (SB-1 through SB-11) were drilled, the boreholes were screened for the presence of flammable gases. Potentially flammable concentrations of gases were not detected. The material disposed at the landfill reportedly was non-putrescible; potentially flammable concentrations of gases were not detected during the installation of the investigative borings.

1.2.2 Summary of RI

Fill material in the western portion of the Site consists of china scrap, gypsum molds, refractory materials, cinders, wood, and some fiberglass insulation. Fill material in these areas ranges in thickness from 16 to 28 feet. Sludge material was encountered at several locations on the Site at thickness ranging from 0.25 to 11 feet.

VOCs were not detected in groundwater, soil, wetland soil, or surface-water samples. Polychlorinated biphenyls (PCBs) were not detected in wetland soil samples collected from landfill berms.

Dissolved metals in groundwater did not exceed the primary drinking water standards. Secondary drinking water standards (based on aesthetic criteria) were exceeded for iron, manganese, magnesium, sodium, and zinc. Nine metals were detected above drinking water standards in unfiltered samples.

Metal concentrations detected in soil samples are within the range of eastern United States background concentrations, with the exception of lead in one sample collected from

Boring SB-3. However, the lead concentration in this sample is within the typical range of concentrations in urban and suburban areas. Eight metals were detected in wetland soil samples at concentrations of potential concern.

Lead was detected above NYSDEC surface-water standards in unfiltered metal samples in SW-5 through SW-12. Zinc was detected above NYSDEC surface-water standards in the unfiltered metals sample SW-8.

1.2.3 COCs

COCs were selected for each medium based on the detection frequency, range of concentration, comparison to background concentrations, general toxicity, comparison to regulatory standards or criteria, and the expected source(s).

VOCs were not detected in groundwater and the dissolved metal concentrations were within primary drinking water standards and indicated minimal impacts to groundwater at the Site. Nine metals were detected above drinking water standards in unfiltered samples. The detection of metals, in particular lead, above drinking water standards in unfiltered samples, coupled with RI results which suggests that the water table is in contact with landfilled materials at some locations, justify the selection of lead as a COC for groundwater.

VOCs were not detected in the soils above the NYSDEC (1994)-recommended soil cleanup objective levels. Metal concentrations in the non-wetland soil were within the reported background concentrations for United States soil (USGS 1984), with the exception of lead detected at 426 mg/kg in SB-3. Average lead concentrations in urban/suburban areas or near highways typically range from 200 to 500 mg/kg (NYSDEC 1994). Based on these data, lead was identified as the only COC in non-wetland soil.

There are no available soil cleanup guidance numbers for wetland soils. The TAGM 4046 levels, which are generally intended to be protective of human health and groundwater quality are not directly applicable within designated wetlands where extended human exposure is not expected. At NYSDEC's direction, the wetland soil data was compared to NYSDEC's Fish and Wildlife's Division's "Technical Guidance for Screening Contaminated Sediment"

(11/93). The sediment screening number for lead in this guidance is 110 ppm ("NYSDEC Sediment Screening Guidance"). That guidance indicates that "[s]ediments can be loosely defined a a collection of fine-, medium and coarse-grain minerals and organic particlees that are found at the bottom of lakes [and ponds], rivers [and streams], bays, estuaries, and oceans (Adams et al., 1992)." (NYSDEC Sediment Screening Guidance at 2). This screening guidance does not include sediment cleanup criteria. In fact, the guidance states, "Risk assessment, risk management, and the results of further biological and chemical tests and analyses are vital tools for managing sediment contamination.. To view sediment criteria in a one-dimensional, go/no go context is to miss potential opportunities for resource utilization through appropriately identified and managed risk." (NYSDEC Sediment Screening Guidance at 2).

We also compared the wetland soil data to the allowable lead levels (40 CFR Part 503) in sludge and then to EPA's underlying Technical Support Document for these federal regulations which examined ten exposure pathways, including an ecological risk pathway of sludge [contaminant source] to soil biota (earth worm – chosen as the most sensitive exposed species) to soil biota predator (small mammal – chosen as the most exposed predator of soil microorganisms). Based upon a review of literature lead toxicity data, bioaccumulation factors, etc. EPA calculated a "reference concentration of pollutant in soil" of 2525 mg/kg for lead. EPA's subsequent lead limit for sludge which could be directly applied to soil was based on the results of the exposure pathway where the most exposed individual was a child and generated an allowable soil lead concentration of 500 ppm (mg/kg). EPA Technical Support Document for the Land Application of Sewage Sludge, Vol. I EPA 822/R-93-001a.).

Within the wetland however, the potential exists for terrestrial wildlife, including earthworms and muskrats, to come into contact with the heavy metals. Thus, the selection of COCs was based upon those heavy metals which might present a threat to wildlife. Neither NYSDEC or EPA has generally issued guidance on wildlife protection levels. Because lead was both the most widespread heavy metal measured in the wetland soil and is the heavy metal which was present in the highest concentration, it was chosen as the indicator heavy metal COC. Sampling done to date clearly indicates that wherever one of the other 7 heavy metals is potentially at a level of concern, lead is also of a concern (and present at much higher levels) at that location.

VOCs were not detected in surface water. Zinc and lead were detected in the surface-water samples and were, therefore, identified as COCs in surface water.

1.2.4 Risk Assessment

A risk assessment was included in the RI Report (Geraghty & Miller, Inc. 1995b); a summary of the identified risks follows:

- Lead and zinc were identified as COCs in surface-water and wetland soil samples collected from the wetland area adjacent to the Site. Lead was identified as a COC in the soil samples collected from the landfill area. Under current conditions, on-site exposure is limited. Workers collecting samples from the SPDES outfall could potentially come in contact with landfill soil, surface water, and wetland soil. The limited exposures reasonably expected to occur under these conditions do not likely pose any risk.

- Residents living near the Site may use Ley Creek for fishing and swimming; however, the available data indicate that these activities are unlikely. The results of the USEPA's Integrated Exposure Uptake Biokinetic (IEUBK) model version 0.99d for lead indicated that lead in fish posed little risk to the local population, even at a relatively high dietary level (5 to 10 percent of the total meat diet). The predicted geometric mean of almost all blood lead (PbB) levels was 4.7 to 5.5 micrograms per deciliter (ug/dL), which is below the regulatory standards of 10 ug/dL.

- The results of the fish and wildlife habitat impact analysis report that the site and its vicinity are of limited value as habitat to fish and wildlife due to the highly industrialized/urbanized nature of the area.

- In addition to the Human Health Risk Assessment which was included in the RI report, a wildlife risk analysis was done for lead. This is included as Appendix A. Based upon that risk analysis, an initial target cleanup level of 600 ppm for lead in the wetland soils is recommended. This level should result in an acceptable risk to wildlife species which may be present in the wetlands.

2. IDENTIFICATION OF REMEDIAL ALTERNATIVES

In this section, the remedial action objectives (RAOs) and the general response actions (GRAs) to accomplish those objectives are defined; and remedial technologies available to achieve the RAOs are described. The technologies frequently implemented for remedial action at a landfill site are considered for the remediation at the Syracuse China Landfill Site.

2.1 REMEDIAL ACTION OBJECTIVES

RAOs are statements that specify site remediation goals and identify which COC, media, and exposure pathway will be addressed by remedial actions. Remedial goals establish exposure levels that are protective of human health and the environment. They are developed considering the requirements of the New York State Standards, Criteria, and Guidelines (NYS-SCGs), the toxic or carcinogenic potential of the COCs, the exposure pathways, and the environmental impacts. The RAOs are used in the screening of technologies and in the development and detailed evaluation of remedial alternatives.

Based on the results of the investigation, the nature and extent of contamination, and the risk assessment, the following RAOs are established for the Site.

- Reduce infiltration and minimize erosion to mitigate the potential migration of soil-bound COCs to the groundwater.

- Reduce risks associated with the potential release of COCs from the soils and wetland soils into Ley Creek.

- Reduce the lead levels in wetland soils to levels which are protective of wildlife which may live or feed within the wetland. As a result of the reduction of lead in wetland soils, arsenic, chromium, copper, mercury, nickel, silver, and zinc will also be reduced.

- Lower the water table beneath the landfill and reduce the potential for leaching of COCs to the downgradient groundwater.

- Excavate approximately 1.3 acres of the landfill to restore this area to the wetland.
- Reduction of potential off-site migration of site contaminants through surface water.
- Closure of the landfill in accordance with relevant and applicable 6NYCRR Part 360 requirements.
- Excavate soils and sediments from settling ponds

2.2 GENERAL RESPONSE ACTIONS

Remedial technologies are categorized in terms of GRAs. GRAs are broad categories of remedial actions capable of addressing the contamination at the Site. GRAs describe, in general terms, these site-specific remedial actions that will satisfy the RAOs and/or cleanup goals for the identified source areas. The GRAs identified for soil, wetland soils, and sludges are as follows:

- No action.
- Limited action
- Containment
- In-situ treatment
- Removal/treatment/disposal.

2.3 SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

The term remedial technologies refers to categories of remedial action that comprise subsets of the GRAs, such as capping or thermal treatment. Process options refer to specific processes within the technology type (e.g., geomembrane cap or rotary kiln incineration). The purpose of this section is to evaluate and select the GRAs, remedial technologies, and process options that are potentially applicable for the site remedial action. The technologies and process options are evaluated based on effectiveness, implementability, and relative cost.

The technologies that have been retained following this screening process are used to develop remedial alternatives for the remedial action at the Site. Assembled remedial alternatives are then subject to a detailed qualitative and quantitative evaluation. Each alternative is evaluated on the basis of overall protection of human health and the environment; compliance with NYS-SCGs; long-term effectiveness and performance; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; cost; and community acceptance. Alternatives are then compared to select the most environmentally sound and cost-effective remedial action for the Site.

It is the intent of Syracuse China to continue to operate pursuant to the SPDES permit issued by the NYSDEC and to utilize SPDES outfall 001 and the settling ponds (see Figure 3-1) that comprise the system for the permitted discharge from the plant. While the remedial technologies that are reviewed in this report will address potential areas of contamination, all remediation efforts contemplate the continued and future use of a SPDES outfall and settling pond system.

In the following sections, the screening of remedial technologies and process options for soils, wetland soil, and sludge at the Site is described in detail. A summary of this screening is presented on Figure 2-1.

2.3.1 Remediation Technologies and Process Options

The following GRAs, remediation technologies, and process options have been initially considered for the remedial action at the Site.

2.3.1.1 No Action

The no-action option, the inclusion of which is required by the National Contingency Plan (NCP), provides a baseline against which other options may be compared. Under no-action, no additional cleanup would be undertaken, and the Site would be left as it now exists.

No action consists of leaving impacted wetland soils in place allowing natural deposits of soils, which will bury or contain pollutants and act as a natural cap. Simultaneously, natural degradation of the COCs occurs in the wetland soils. Natural wetlands are capable of treating toxic metal contaminated waters and constructed wetlands have been used to remove toxic metals in some CERCLA sites.

2.3.1.2 Limited Action

Limited action involves imposing access restrictions to the Site. This option would include fencing of the Site to prohibit public access. Limited action would temporarily limit public access to on-site contaminants, but cannot prevent exposure during unauthorized access. This action can also be applied in conjunction with other containment or treatment technologies and therefore will be retained for further evaluation.

2.3.1.3 Containment

Containment is a response category in which physical barriers are used to prevent infiltration of storm water and direct precipitation into the contaminated subsurface soils and/or to prevent or divert the horizontal flow of groundwater into or from the contaminated area. As a result, the potential for contaminant migration from the surface and subsurface soils into the groundwater and surface water is significantly reduced by horizontal barriers. Vertical barriers can divert the groundwater flowing into the contaminated area and eliminate the leaching potential of the COCs from the contaminated material. The vertical barriers can also be used to prevent further migration of contaminated groundwater. Capping is the containment technology under consideration for the Site.

2.3.1.3.1 Capping

Capping involves the placement of an engineered cover over contaminated soil or waste areas. Capping prevents direct contact with contaminated soil and minimizes contaminant migration through air or run-off pathways. This technology prevents migration of contaminants by physically isolating them from driving forces, such as precipitation percolation, surface-water run-off, and wind. Capping can be completed relatively quickly using readily available materials. Standard construction equipment is used to implement this technology. The main disadvantage of capping is the need for long-term maintenance;

however, with satisfactory annual maintenance, a cap can provide a functional solution to a contamination problem for the required length of time. In addition, the entire site work and capping of the landfill need to be done, to minimize or eliminate soil erosion and sediment transport from the site. The surface-water run-off from the cap would be intercepted by constructed swales at the toe of the cap and directed to discharge the flow to the wetlands. The surface-water run-off toward the landfill is also to be diverted to wetland area. The capping would be done in accordance with the New York State Guidelines for Soil Erosion and Sediment Control, and applicable and relevant 6NYCRR Part 360 requirements. Soil, and geomembrane caps are potential process options for the Site. Each of these types of caps is discussed below.

Soil Cap: A soil cap is constructed by regrading the Site and then spreading and compacting a 24-inch thick barrier/protective layer of soil (not low permeability) and a 6-inch thick topsoil layer on the regraded area (Figure 2-2). The topsoil layer supports plant life over the soil cover and provides drainage to minimize surface-water infiltration. Proper grading with sufficient slopes enhances surface run-off instead of permitting precipitation to infiltrate.

Materials available at the site can be used for the soil cover. The soil cap is reliable in isolating the COCs, but proper maintenance of the soil cap is required to ensure reliability and prevent future exposure of the COCs. Therefore, an operation and maintenance (O&M) plan must be followed during the operational time of the soil cover cap.

Geomembrane Cap: A typical geomembrane cap is made up of a 40-mil very low density polyethylene (VLDPE) synthetic membrane overlain with a 2-foot thick protective soil cover and a 6-inch thick topsoil layer, with vegetation (Figure 2-2). The topsoil layer supports vegetation over the area and provides drainage to minimize surface-water infiltration. This membrane cap provides a high level of protection against both infiltration and direct human contract with underlying contaminated materials. This cap is highly reliable in preventing future exposure of the COCs due to the synthetic barrier layer. A proper O&M plan must be followed to maintain the protective and vegetative layers of the cap.

Summary: Capping is a viable remedial technology that would serve to prevent the migration of COCs from soil to groundwater and surface water at the site. Consequently, all of the process options for capping will be retained for further evaluation as indicated on Figure 2-1.

2.3.1.3.2 Vertical Barriers

Vertical barriers are physical barriers which impede the horizontal flow of contaminated water or eliminate groundwater flow into a contaminated area. The vertical barriers considered for this site are a slurry wall and interceptor trench. This technology prevents the flow of groundwater into the fill material in the landfill and hence eliminate the potential for leaching of COCs from the fill material into the flowing groundwater. The installation of the cap would be expected to locally lower the water table, possibly eliminating the need for groundwater diversion. Normally these barriers can be constructed using readily available materials and conventional and specialized equipment. The implementability of this depends on the site space and accessibility.

The need for consideration of a vertical barrier is driven by the detection of metals in unfiltered groundwater samples and the potential that the water table is in contact with landfilled materials in some areas. However, during groundwater sampling, turbidities greater than 50 NTUs were measured in samples from each of the monitoring wells and therefore were filtered prior to analysis. Both dissolved (filtered) and total (unfiltered) results were then reported. Prior to final design, additional well development and modifications to groundwater sampling protocols should be attempted to further reduce turbidity, if possible. Lower concentrations of metals in subsequent samples having reduced turbidities may ultimately eliminate the need for a vertical barrier.

Slurry Wall: A slurry wall can be used at the Site to redirect the groundwater flow upgradient of the landfill. Typically slurry wall construction involves soil-bentonite or cement-bentonite mixtures. The construction of slurry wall involves the excavation of a vertical trench and the injection of slurry into the excavated trench. Construction of slurry wall at this site would require special equipment and would be difficult to implement due to the space requirements.

Interceptor trench: An interceptor trench can be used at the Site to redirect the groundwater flow upgradient of the landfill. Typically the interceptor trench would be constructed by excavating a trench to the required depth. The down stream face and the bottom of the excavated trench would be lined with a geosynthetic membrane to create an impermeable barrier. The bottom portion of the trench would be filled with clean stone and a perforated corrugated drainage pipe also would be installed within the clean stone envelope. The stone envelope would be enclosed by filter fabric to prevent clogging of the stone envelope. The remainder of the trench would be backfilled to grade using common fill material. The stone envelope and drainage pipe would be sloped to the desired discharge location. The length of the trench would be dependent upon final cap design.

Summary: Vertical barrier is a viable technology that would prevent potential migration of COCs to the surface water and wetlands at the site. Consequently the interceptor trench option will be retained for evaluation as indicated in Figure 2-1.

2.3.1.4 In-Situ Treatment

In-situ treatment systems degrade, remove, or detoxify hazardous components in place. In-situ treatment occurs primarily within the subsurface soil, thus differing from other on-site treatment technologies that are primarily aboveground processes. In-situ methods reduce the need for soil excavation and transportation to off-site landfills or to off-site treatment facilities. In-situ treatment technologies are generally not as developed as other available technologies for treatment of contaminated soils, but some of them have been used successfully to remediate various sites. Two in-situ technologies, thermal treatment and physical/chemical treatment are considered for the Site.

2.3.1.4.1 Thermal Treatment

Thermal treatment technologies involve the treatment of wastes at relatively high temperatures to achieve either destruction or desorption of the COCs. In-situ vitrification (ISV) is the in-situ thermal treatment under consideration for the Site.

ISV involves placing an array of electrodes in the soil to be vitrified and applying electric power to heat and melt the soil. A high current is passed through these electrodes, heating the adjacent soil to approximately 2,900 to 3,600 degrees Fahrenheit (°F) and causing the soil to melt. As the vitrification process spreads downward and outward, it thermally destroys contaminants by pyrolysis. Off-gases migrate to the surface where they are treated prior to atmospheric release. When the electric current ceases, the mass cools and solidifies into a glassy, solid matrix, similar in form and durability to the igneous rock obsidian. This technology is primarily used to encapsulate non-volatile organic elements and can be used for non-volatile metals. The process has potentially adverse impacts to the environment when the contaminants are volatile metals. The ISV process will not be effective for the COC lead, (which is volatile at the temperature necessary for ISV), and will, therefore, not be retained for further evaluation.

2.3.1.4.2 Physical/Chemicial Treatment

Physical treatment processes are used either to separate contaminants from soil by physical means or to immobilize them within the soil matrix. Chemical treatment processes alter the chemical structure of the contaminants to produce a less hazardous residue than the original waste. In practice, physical and chemical treatment processes often overlap, and they are therefore considered together. A physical/chemical technology process option discussed under this general response action category is solidification/stabilization.

In-situ solidification/stabilization involves the direct injection of reagents and additives into the subsurface soil using specialized machinery with injection augers and rotary-type mixers for blending. This process has the potential to reduce the mobility of inorganic contaminants and has been used on hazardous waste sites with varying degrees of success.

Solidification/stabilization is more commonly applied to inorganic constituents and is better suited for such applications. Contaminants in the wetlands appear to be surficial and limited in quantity. The treatment of wetland soils would require removal for effective treatment. Stabilization of the wetland soils using heavy equipment for in-situ method will disturb larger extent of the wetlands at the Site. This process will not be retained for further evaluation because of the inapplicability for the wetland soils and the high cost associated with this process.

2.3.1.5 Removal/Treatment/Disposal

Excavation and removal of contaminated material for treatment or land disposal are performed extensively at hazardous waste sites. Excavation of sludge and wetland soils can be achieved by employing standard excavating and dredging equipment. For remediation at the Site, the excavated material can be transported off-site, to a waste disposal facility or be relocated within the Syracuse China Landfill (with or without on-site treatment) and capped.

Excavation and removal has proven to be an effective means of addressing contaminated soil and therefore will be retained for further consideration. Two ex-situ on-site treatment options and two disposal options related to excavation and removal are discussed in this section.

2.3.1.6 Ex-Situ On-Site Treatment

Ex-situ treatment of soils involves utilizing a technology that degrades, removes, or immobilizes COCs. Thermal and physical/chemical treatment technologies are considered for this option.

2.3.1.6.1 Thermal Treatment

Thermal treatment technologies involve the treatment of wastes at relatively high temperatures to achieve either destruction or desorption of COCs. Rotary kiln incineration has been selected as a thermal treatment option to address the contaminated wetland soils and sludges.

Incineration treats organic contaminants in solids and liquids by subjecting them to temperatures greater than 1,000 °F in the presence of oxygen. This temperature causes the volatilization and combustion of the organic contaminants, converting them to carbon dioxide (CO_2), water, hydrogen chloride (HCl), nitrogen oxides (NO_x), and sulfur oxides (SO_x). Rotary kiln incinerators are the most well developed, proven, and commercially available form of thermal destruction. These incinerators are slightly inclined, refractory-lined cylinders. Soil and auxiliary fuel are injected into the high end of the kiln and passed through the combustion zone as the kiln slowly rotates. Temperatures within the combustion zone typically range from 1,200 to 1,800 °F, and retention times vary from several minutes to an hour or more. Organic contaminants are oxidized to gases and inert ash within this zone, with ash being removed at the lower end of the kiln. Flue gases are passed through a secondary combustion chamber and then through air pollution control units for particulate and acid gas removal. The presence of the volatile metal, lead, makes this technology impractical; therefore, this technology is not retained for further analysis.

2.3.1.6.2 Physical/Chemical Treatment

As previously stated, physical treatment processes are used either to separate contaminants from soil by physical means or to immobilize them within the soil matrix. Chemical treatment processes alter the chemical structure of the contaminants to produce a less hazardous residue than the original waste. In practice, physical and chemical treatment processes often overlap, and they are therefore considered together. A physical/chemical technology process option discussed under this general response action category is solidification/stabilization.

The excavated sludge and wetland soils will require dewatering followed by particle classification (which removes oversized material) as preconditioning/pretreatment. Dewatering is normally required to reduce the moisture content of the excavated material, enhancing the handling characteristics, and preparing the material for further treatment and disposal. Common industrial methods of dewatering slurries include centrifugation, dewatering lagoons, filtration, gravity thickening, and filter presses. The water generated by the dewatering process generally contains low concentrations of contaminants and may require treatment The excavated material will be dewatered in order to satisfy the specific solidification/stabilization process requirements, in accordance with the SW-846 "Paint Filter" test method.

Both stabilization and solidification refer to treatment processes that are designed to accomplish one or more of the following goals: improve the handling and physical characteristics of the contaminated soil, decrease the transfer surface area of the soil mass, and limit the solubility of hazardous soil contaminants.

The terms stabilization and solidification have been used interchangeably because of the similarity and overlap between these processes. When they are distinguished from each other, stabilization usually involves the addition of reagent to maintain hazardous constituents in their least mobile or least toxic form, with or without changing the physical characteristics of the soil mass. Solidification usually results in the production of a solid block of treated soil with high structural integrity.

Stabilization processes involve the mixing of contaminated soil with stabilizing or binding reagents. A variety of reagents are available, including cement-based, pozzolanic-based, silicate-based, thermoplastic-based, or organic-polymer-based reagents. These reagents are typically added to contaminated soil in aboveground tanks or mixing pits, and the stabilized mixture is subsequently moved for curing and final disposal. A wide variety of stabilization/solidification processes is available. The most suitable one for a particular site is a function of the site-specific soil and contaminant physical/chemical characteristics. In addition to the choice of reagents, a number of additives can be used to control the curing rate or to enhance the properties of the final treated product.

Stabilization/solidification is a proven and well-established technology for the immobilization of inorganic contaminants. Implementability of this process option is difficult due to the high variation of particle sizes in the soil at the Site. However, the option is implementable for the sludge and wetland soils; therefore, this process is retained for further analysis.

2.3.1.7 Disposal

Disposal of excavated, treated or untreated soils may take place on- or off-site. On- and off-site disposal options are described below.

2.3.1.7.1 On-Site Disposal

The material from the potential sludge area, soils from sludge ponds, and wetland area will be excavated. The excavated material, with or without treatment, may be spread in the area of the landfill to be capped. The COCs in the sludge and wetland soil are metals and the potential exposure route is via leaching to groundwater and surface water. After the excavated material has been disposed on-site, the potential for leaching of COCs from the excavated material will be minimized by the installation of a cap.

The widely used presumptive remedy for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) landfill sites is primarily containment (USEPA 1993). The absence of any contaminant plume and landfill gas at the Site makes capping of the on-site landfill the presumptive remedy for the Site. Therefore, placement of the excavated material in the landfill before capping is the most feasible process option. This option is retained for further analysis.

2.3.1.7.2 Off-Site Resource Compensation and Recovery Act Landfill

Contaminated soils can be excavated and hauled away to a Resource Conservation and Recovery Act (RCRA)-permitted hazardous waste treatment/disposal site if allowed under the Land Ban criteria of 40 Codes of Federal Regulations (CFR) Parts 264, 265, 266, 268, and 271. The contaminated soils may have to be treated prior to disposal.

The major advantage of off-site disposal options over on-site is elimination of the long-term monitoring requirements of capping; off-site disposal options are usually existing, defined, readily accessible, and proven.

The major disadvantage of off-site disposal is the lack of a reduction in the quantity or toxicity of the contaminated soil. As a result, there is a continuing long-term liability potential due to contaminant migration from the disposal facility, in addition to the environmental health risks and cost impacts associated with transport of hazardous materials off-site. Off-site landfilling of hazardous materials is becoming increasingly difficult and more expensive because of increased regulatory control of this technology. CERCLA requires treatment, if deemed necessary, and there are statutory preferences for the treatment of contaminants in CERCLA. Therefore, excavation and off-site disposal are less acceptable than in the past. For these reasons, this technology is not retained for further analysis.

3. DEVELOPMENT OF REMEDIAL ALTERNATIVES

In the previous sections of this FFS, general response actions and the related remedial technologies and process options were identified. A screening of remedial technologies and process options was completed to narrow the list of process options under consideration for remedial action at the Site. In this section, the remedial technologies and process options that were retained are combined into remedial action alternatives.

3.1 REMEDIAL ACTION ALTERNATIVES

The remedial action alternatives selected for the remediation of the Syracuse China Landfill are as follows:

Alternative 1: No Action.

Alternative 2: Limited Action.

Alternative 3A: Excavation, Relocation, Covering with Soil Cap, and Leaving Wetland Soil for Natural Attenuation.

Alternative 3B: Excavation, Relocation, Covering with Geomembrane Cap, and Leaving Wetland Soil for Natural Attenuation.

Alternative 4A: Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap.

Alternative 4B: Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap.

Alternative 5A: Excavation, Relocation, and Covering with Soil Cap.

Alternative 5B: Excavation, Relocation, and Covering with Geomembrane Cap.

Alternative 6A: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap.

Alternative 6B: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap.

Alternative 7A: Installation of Interceptor Trench, Excavation, Relocation, and Covering with Soil Cap.

Alternative 7B: Installation of Interceptor Trench, Excavation, Relocation, and Covering with Geomembrane Cap.

Not all of the Part 360 closure requirements have been included in these alternatives in order to simplify their presentation. During the design phase, the necessity for any omitted Part 360 element will be evaluated. Gas vents consisting of PVC piping will be installed in the capped portion of the landfill. The china fill material already in place will serve as the gas venting layer.

3.1.1 Alternative 1: No Action

The no-action alternative is provided as a baseline for comparison with other alternatives selected for remediation at the Site. Under this alternative, no additional remedial activities will be performed and the Site access will not be further restricted. COCs will be left in place.

Under this alternative, review of the Site will be performed on a 5-year basis to determine if additional remedial action should be implemented.

3.1.2 Alternative 2: Limited Action

Components of this alternative would include the following:

- Limit access to the public.
- Restrict use of the area.
- Implement public education programs.
- Perform groundwater monitoring.

This alternative is a limited action alternative involving institutional controls to restrict human exposure to the COCs identified at the Site. This alternative will restrict access to the public and restrict any activities at the Site other than environmental and SPDES monitoring. The access to the site will be restricted using a chain-link fence around the entire landfill area. The existing fence south of Factory Avenue shall be used and additional fence should be installed to completely restrict the access to the landfill site. Environmental monitoring would include sampling and analysis of groundwater and surface water. Five-year reviews of the Site would include a spatial analysis of existing data to monitor for increasing or decreasing trends and would also include a determination as to whether additional remedial action should be implemented.

3.1.3 Alternative 3A: Excavation, Relocation, Covering with Soil Cap, and Leaving Wetland Soils for Natural Attenuation

The components of Alternative 3A include the following:

- Excavate sludge and fill.
- Dewater excavated sludge as conditions require.
- Relocate the excavated fill material.
- Spread treated material in the landfill.
- Install soil cover cap.
- Install surface drainage control structures.
- Perform proper maintenance.
- Perform additional delineation sampling.

This alternative involves excavating sludge from the sludge pond and settling ponds, removing sludge from the sludge areas found in the approximate locations shown on Figure 2-2, excavating fill material beyond the capping limit. The excavated fill material from the eastern portion of the landfill will be relocated in the area to be capped. The excavated sludge material may be dewatered when necessary in accordance with the SW-846 "Paint Filter" test method to increase handling characteristics. The dewatered material will be spread in the landfill area. The regrading of the area for the capping will be done not to further encroach any of the wetland areas. The final configuration of the ponds will be made during the design phase since it is not possible to determine if the current configuration will be able to be integrated into the area to be capped. However, as stated above, contaminated sediments from the ponds will be excavated, dewatered if necessary and placed under the cap. The area will be capped using a 24-inch thick soil (barrier/protective) layer and a 6-inch thick topsoil cover. The capped area will be vegetated to protect the slopes and minimize erosion of the capping material. The wetland soils will be left in place for natural attenuation. Capping will reduce the infiltration of water due to precipitation that may transport potential contamination from the soil to the groundwater or surface water. The capping will also eliminate the surface run-off of potential contaminants. The entire site work will be performed to minimize or eliminate soil erosion and sediment transport from the site. A peripheral drainage swale system at the toe of the landfill cap will be constructed to direct the run-off from the cap toward the wetland area. In addition, the run-off from the off-site toward the landfill will also be rerouted toward the wetland area. All the temporary and permanent drainage control structures will be in accordance with the State Soil Conservation Requirements. The installed cap will be maintained to eliminate any erosion and exposure to the COCs. The preliminary extent of the capping area for Alternative 3 is shown on Figure 2-2.

3.1.4 Alternative 3B: Excavation, Relocation, Covering with Geomembrane Cap, and Leaving Wetland Soil for Natural Attenuation

The components of Alternative 3B are the same as those for Alternative 3A, except that a geomembrane will be added as a barrier layer in the soil cap. The geomembrane layer will provide more effective elimination of infiltrating precipitation.

3.1.5 Alternative 4A: Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap

The components of Alternative 4A include the following:

•Excavate sludge, fill, and wetland soil.

- Dewater excavated sludge and wetland soil as conditions require.
- Treat excavated sludge and wetland soil using solidification/stabilization.
- Relocate the excavated fill material.
- Spread treated material in the landfill.
- Install soil cover cap.
- Install surface drainage control structures.
- Perform additional delineation sampling.
- Perform proper maintenance.

This alternative involves excavating sludge from the sludge pond and settling ponds, removing sludge from the sludge areas found in the approximate locations shown on Figure 2-2, excavating fill material beyond capping material, and dredging wetland soils from the wetlands to adhere the target clean-up levels established for the site (see Appendix A). The areal extent of lead deposits in the wetlands will be determined by additional sampling and the impacted wetland soils will be excavated. Approximately 1.3 acres of the landfill, in the approximate location shown on Figure 2-2, will be excavated to restore this area to the wetlands. The excavated fill material from the eastern portion of the landfill will be consolidated and treated on-site using solidification/stabilization. The excavated sludge and wetland soil will be dewatered to increase the handling characteristics and to suit the requirements for solidification/stabilization. The treated material will be spread in the landfill area. The regrading of the area for the capping will be done not to further encroach any of the wetland areas. The area will be capped using a 24-inch thick soil layer and a 6-inch thick topsoil cover. The capped area will be vegetated to protect the slopes and minimize erosion of the capping material. The wetland will be allowed to re-vegetate naturally, subject to a need to temporarily stabilize soil through re-seeding. Capping will reduce the infiltration of water due to precipitation that may transport potential contamination from the soil to the groundwater or surface water. The capping will also eliminate the surface run-off of potential contaminants. The entire site work would be performed to minimize or eliminate soil erosion and sediment transport from the site. A peripheral drainage swale system at the toe of the landfill cap would be constructed to direct the run-off from the cap toward the wetland area. In addition, the run-off from the off-site toward the landfill will also be rerouted toward the wetland area. Temporary and permanent drainage control structures will be in accordance with the State Soil Conservation Requirements. The installed cap will be maintained to eliminate erosion and exposure to the COCs. The preliminary extent of the capping area for Alternative 4A is shown on Figure 2-2.

3.1.6 Alternative 4B: Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap

The components of Alternative 4B are similar to those for Alternative 4A, except that a geomembrane will be added as a barrier layer in the soil cap. A geomembrane layer will provide more effective elimination of infiltrating precipitation.

3.1.7 Alternative 5A: Excavation, Relocation, and Covering with Soil Cap

The components of Alternative 5A include the following:

- Excavate sludge, fill, and wetland soil.
- Dewater excavated sludge and wetland soil as conditions require.
- Relocate the excavated fill material.
- Spread treated material in the landfill.
- Install soil cover cap.
- Install surface drainage control structures.
- Perform additional delineation sampling.
- Perform proper maintenance.

The components of Alternative 5A are the same as those for Alternative 4A, except that the excavated sludge and wetland soils will be spread in the landfill without undergoing any treatment except dewatering. The COCs in the sludge and wetland soil are metals, and capping will prevent exposure to, and leaching of, these metals. Therefore, disposal without treatment, is also protective of human health and the environment at the Site.

3.1.8 Alternative 5B: Excavation, Relocation, and Covering with Geomembrane Cap

The components of Alternative 5B are the same as those for Alternative 4B, except that the excavated sludge and wetland soils will be spread in the landfill without undergoing any treatment.

3.1.9 Alternative 6A: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap

The components of Alternative 6A include the following:

- Excavate sludge, fill, and wetland soil.
- Dewater excavated sludge and wetland soil as conditions require.
- Treat excavated sludge and wetland soils using solidification/stabilization.
- Relocate the excavated fill material.
- Spread treated material in the landfill.
- Install soil cover cap.
- Install interceptor trench, if necessary and feasible, along the upgradient portion of the landfill.
- Install surface drainage control structures.
- Perform additional delineation sampling.
- Perform proper maintenance.

This alternative involves installation of an interceptor trench along the upgradient portion of the landfill, excavating sludge and wetland soils from the sludge pond and settling ponds, removing sludge from the sludge areas found in the approximate locations shown on Figure 2-2, excavating fill material beyond capping limit, and dredging wetland soils from the wetlands to achieve the target clean-up levels established for the site (see Appendix A). The areal extent of lead deposits in the wetlands will be determined by additional sampling and the impacted wetland soils will be excavated as necessary. Approximately 1.3 acres of the landfill, in the approximate location shown on Figure 2-2, will be excavated to restore this area to the wetlands. The excavated fill material from the eastern portion of the landfill will be consolidated and treated on-site using solidification/stabilization. The excavated sludge and wetland soil will be dewatered to increase the handling characteristics and to suit the requirements for solidification/stabilization. The treated material will be spread in the landfill area. The regrading of the area for the capping will be done not to further encroach the wetland areas. The area will be capped using a 24-inch thick soil layer and a 6-inch thick topsoil cover. The capped area will be vegetated to protect the slopes and minimize erosion of the capping material. The wetland will be allowed to re-vegetate naturally, subject to a need to temporarily stabilize soil through re-seeding. Capping will reduce the infiltration of water due to precipitation that may transport potential contamination from the soil to the groundwater or surface water. The capping will also eliminate the surface run-off of potential contaminants. The entire site work will be performed to minimize or eliminate soil erosion and sediment transport from the site. A peripheral drainage swale system at the toe of the landfill cap will be constructed to direct the run-off from the cap toward the wetland area. In addition, the run-off from off-site toward the landfill will also be rerouted toward the wetland area. Temporary and permanent drainage control structures will be in accordance with the State Soil Conservation Requirements. The installed cap will be maintained to eliminate any erosion and exposure to the COCs. The preliminary extent of the capping area for Alternative 6A is shown on Figure 2-2. The location, extent and detail of the interceptor trench is shown on Figure 3-1.

3.1.10 Alternative 6B: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap

The components of Alternative 6B are similar to those for Alternative 6A, except that a geomembrane will be added as a barrier layer in the soil cap. A geomembrane layer will provide more effective elimination of infiltrating precipitation.

3.1.11 Alternative 7A: Installation of Interceptor Trench, Excavation, Relocation, and Covering with Soil Cap

The components of Alternative 7A include the following:

- •Excavate sludge, fill, and wetland soil.
- •Dewater excavated sludge and wetland soil as conditions require.
- •Relocate the excavated fill material.
- •Spread treated material in the landfill.
- •Install soil cover cap.
- •Install interceptor trench, if necessary and feasible, along the upgradient portion of the landfill.
- •Install surface drainage control structures.
- •Perform additional delineation sampling.
- •Perform proper maintenance.

The components of Alternative 7A are the same as those for Alternative 6A, except that the excavated sludge and wetland soils will be spread in the landfill without undergoing any treatment. The COCs in the sludge and wetland soil are metals, and capping will prevent exposure to, and leaching of, these metals.

3.1.12 Alternative 7B: Installation of Interceptor Trench, Excavation, Relocation, and Covering with Geomembrane Cap

The components of Alternative 7B are the same as those for Alternative 7A, except that a geomembrane will be added as a barrier layer in the soil cap. A geomembrane layer will provide more effective elimination of infiltrating precipitation.

4. DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

In this section of the FFS, the remedial alternatives described in the previous section are analyzed to determine the effectiveness of each alternative in achieving the RAOs at the Site.

4.1 EVALUATION OF REMEDIAL ALTERNATIVES

The remedial alternatives are evaluated to determine the effectiveness of each alternative in addressing the impacts to human health and the environment attributed to the COCs at the Site. Each alternative is evaluated based on the following evaluation criteria:

- Overall protection of human health and the environment
- Compliance with NYS-SCGs
- Long-term effectiveness and permanence
- Short-term effectiveness
- Reduction of toxicity, mobility, or volume
- Implementability
- Cost
- Community acceptance

The first two criteria are referred to as threshold criteria. The next five criteria are commonly referred to as primary balancing criteria. These seven criteria are further described in this section and make up the major portion of the evaluation.

The last criterion is commonly referred to as a modifying criterion. This criterion will be evaluated following completion of the FFS and public review and comment.

4.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion is used to assess whether each alternative is protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under other evaluation criteria, especially long-term effectiveness and performances, short-term effectiveness, and compliance with NYS-SCGs.

4.1.2 Compliance with NYS-SCGs

This evaluation criterion is used to determine how each alternative complies with NYS-SCGs. Relevant standards include the Standards for Groundwater (NYSDEC 1991) and the New York and Federal Drinking Water Standards. The relevant and applicable portions of 6NYCRR 360 closure requirements will be observed. Relevant guidance, where applicable, also includes "NYSDEC's Fish and Wildlife Division's Technical Guidance for Screening Contaminated Sediment" (11/93); also considered "USEPA's Technical Support Document for the Land Application of Sewage Sludge" (EPA 822/%-93-001).

4.1.3 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the results of a remedial action in terms of its permanence and the quantity/nature of waste or residual levels of contamination remaining at the Site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the residual levels of COCs remaining at the site.

4.1.4 Reduction of Toxicity, Mobility, or Volume

This evaluation criterion assesses the ability of the remedial alternative to permanently and significantly reduce toxicity, mobility, or volume of the COCs.

4.1.5 Short-Term Effectiveness

This evaluation criterion assesses the effects of the alternative during the construction and implementation phase until remedial response objectives are met. Under the criterion, alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action.

4.1.6 Implementability

This evaluation criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation.

4.1.7 Cost

The capital and O&M cost estimates are derived for each alternative and used as a basis for comparison in the evaluation of alternatives. Detailed capital cost estimates and O&M costs for each alternative are included in Appendix B.

4.1.7.1 Capital Costs

Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor, and materials necessary to install remedial actions. Indirect costs include expenditures for engineering and other services that are not part of actual installation activities, but are required to complete the installation of remedial alternatives.

4.1.7.2 Operation and Maintenance Costs

Annual O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. Such costs include occasional reevaluation of the site during and after remedial efforts have been taken. Although the schedule for reevaluation of a site during and after remediation is determined on a case-by-case basis, for the purposes of this study, it has been assumed that the source areas will be reevaluated every 5 years (worst-case scenario) until completion of the remediation.

4.1.7.3 Present-Worth Analysis

A present-worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This procedure allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. For this evaluation, a discount interest rate of 7 percent has been assumed.

4.2 ANALYSIS OF REMEDIAL ALTERNATIVES

In this section, each alternative is analyzed in reference to the evaluation criteria described in Section 4.1 (Evaluation of Remedial Alternatives). A summary of the results of this analysis is provided in Table 4-1.

4.2.1 Alternative 1: No Action

Alternative 1, the no further action alternative, is evaluated as a baseline for comparison with other alternatives, as required by the NCP. This alternative would require that no additional action be undertaken to reduce or remove the COCs from the soil, wetland soil, and sludge.

This alternative is not in compliance with the NYS-SCGs and does not offer any increased overall protection of human health and the environment. No remedial action is associated with this alternative; therefore, implementation poses no risks to workers or the community. The environmental impact will remain at the existing level. This alternative offers no reduction of toxicity, mobility, or volume through treatment and is easy to implement. There is no capital cost associated with the implementation of this alternative. Annual cost associated with the monitoring will be the only cost for this alternative. The estimated costs for implementing Alternative 1 are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.2 Alternative 2: Limited Action

This alternative offers limited increased protection to human health and the environment. Maintaining fencing and access restrictions can prevent human and animal contact with impacted soil, sludge, and wetland soils at the Site. The potential for unauthorized access to the impacted environmental media would still exist. The potential for migration of COCs would still exist as the impacted soil, sludge, and wetland soils would be exposed to natural forces, such as wind and rain.

Implementation of this alternative will not directly reduce the COCs in the impacted media; however, natural attenuation of the COCs will occur over time. Long-term benefits would include reduction of human exposure to impacted media. The threat of animal exposure to the impacted media will continue since the media are exposed and the area is not sealed. This alternative is readily implementable.

The toxicity, mobility, and volume of contamination will remain at the same level. The potential for leaching of COCs into groundwater and surface water will not be reduced

The costs for this alternative would consist of administrative expenses related to implementing access restrictions, instituting a public education program, and long-term monitoring at the Site. There will be additional capital cost for fencing. The estimated costs for implementation of Alternative 2 are given in Table 4-2. A cost breakdown for this alternative is provided in Appendix B.

4.2.3 Alternative 3A: Excavation, Relocation, Covering with Soil Cap, and Leaving Wetland Soil for Natural Attenuation

Alternative 3A will be protective of human health and partially protective to the environment. The sludge and fill are excavated and spread in the landfill without treatment. The landfill would then be covered using a soil cap.

Capping would reduce the leaching of COCs to the groundwater and surface water and will minimize migration of COCs to off-site receptors. Capping would also reduce the potential for contaminants to come into contact with humans and animals and would reduce erosion.

This alternative is mostly in compliance with the NYS-SCGs, but does not provide the low permeability barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and soil erosion, may be associated with excavation, grading, and cap installation. Proper implementation of a site-specific HASP would mitigate any risks associated with construction operations. Standard dust control measures and proper protection would control exposure to workers during construction.

This alternative would not reduce the toxicity or volume of contaminated media. It will reduce the mobility of the COCs by placing the contaminated media below a cap.

The excavated sludge will not be chemically treated before being placed in the on-site landfill. There is not a measurable benefit to treatment of the sludge since the COCs are relatively immobile metals and capping would minimize the possibility of leaching metals into groundwater or transport by surface-water run-off.

This alternative is implementable and effective in containing the COCs in the long-term and may be considered a permanent solution.

The capital cost estimate for implementation of this alternative includes the costs of the excavation and relocation of sludge, the construction of the cap and engineering and administration. The annual cost would include environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 3A are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.4 Alternative 3B: Excavation, Relocation, Covering with Geomembrane Cap, and Leaving Wetland Soil for Natural Attenuation

The components of Alternative 3B are the same as those for Alternative 3A, except that a geomembrane will be added as a barrier layer in the soil cap. The geomembrane layer will provide more effective elimination of infiltrating precipitation.

Alternative 3B will be protective of human health and partially protective to the environment. The sludge and fill are excavated and spread in the landfill without treatment. The landfill would then be covered using a geomembrane cap.

Capping would reduce the leaching of COCs to the groundwater and surface water and will minimize migration of COCs to off-site receptors. Capping would also reduce the potential for contaminants to come into contact with humans and animals and would reduce erosion.

This alternative is in compliance with the NYS-SCGs. The geomembrane layer will be the barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and soil erosion, may be associated with excavation, grading, and cap installation. Proper implementation of a site-specific HASP would mitigate any risks associated with construction operations. Standard dust control measures and proper protection would control exposure to workers during construction.

This alternative would not reduce the toxicity or volume of contaminated media. It will reduce the mobility of the COCs by placing the contaminated media below a cap.

The excavated sludge will not be chemically treated before being placed in the on-site landfill. There is not a measurable benefit to treatment of the sludge since the COCs are relatively immobile metals and capping would minimize the possibility of leaching metals into groundwater or transport by surface-water run-off.

This alternative is implementable and effective in containing the COCs in the long-term and may be considered a permanent solution.

The capital cost estimate for implementation of this alternative includes the costs of the excavation and relocation of sludge, the construction of the cap and engineering and administration. The annual cost would include environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 3B are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.5 Alternative 4A: Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap

Alternative 4A will be protective of human health and the environment. The sludge and wetland soil will be excavated and treated on-site using solidification/stabilization. After the stabilization of the sludge and wetland soil material, it will spread in the landfill and covered using a soil cap. Capping will reduce the leaching of COCs to the groundwater and surface water, and minimize the potential of migration of COCs to off-site receptors. Capping will also reduce the potential for contaminants to come into contact with humans and animals and will reduce erosion.

This alternative is mostly in compliance with the NYS-SCGs, but does not provide a barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and erosion, may be associated with removal, treatment, and cap installation. Proper implementation of a site-specific health and safety plan (HASP) would mitigate risks associated with construction operations. Standard dust control measures would control exposure to workers during construction. This alternative is effective in containing the COCs in the long-term and may be considered as a permanent solution.

This alternative would not reduce the toxicity or volume of contaminated media, but it will reduce the mobility of COCs through the use of stabilization/solidification and capping. This alternative is implementable. On-site treatment and construction of the cap is not expected to involve any implementation problem.

The capital cost estimate for implementation of this alternative includes the costs of delineation of the extent of contamination in the wetlands, the treatment of excavated sludge and wetland soil, construction of the cap, engineering and administration. The annual cost will include environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 4A are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.6 Alternative 4B: Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap

This alternative is similar to Alternative 4A, with the exception of the use of a geomembrane layer in the cap to reduce infiltration of precipitation. The items discussed for Alternative 4A applies to this alternative, also. The geomembrane layer will be the barrier layer required by Part 360.

The estimated costs for implementing Alternative 4B are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.7 Alternative 5A: Excavation, Relocation, and Covering with Soil Cap

Alternative 5A will be protective of human health and the environment. The sludge and wetland soil are excavated and spread in the landfill without treatment. The landfill would then capped using a soil cap.

Capping would reduce the leaching of COCs to the groundwater and surface water and will minimize migration of COCs to off-site receptors. Capping would also reduce the potential for contaminants to come into contact with humans and animals and would reduce erosion.

This alternative is mostly in compliance with the NYS-SCGs, but does not provide a barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and soil erosion, may be associated with excavation, grading, and cap installation. Proper implementation of a site-specific HASP would mitigate any risks associated with construction operations. Standard dust control measures and proper protection would control exposure to workers during construction.

This alternative would not reduce the toxicity or volume of contaminated media. It will reduce the mobility of the COCs by placing the contaminated media below a cap.

This alternative is similar to Alternative 4A, except that the sludge and wetland soil would not be chemically treated before being placed in the on-site landfill. There is not a measurable benefit to treatment of the sludge and wetland soils since the COCs are relatively immobile metals and capping would minimize the possibility of leaching metals into groundwater or transport by surface-water run-off.

This alternative is implementable and effective in containing the COCs in the long-term and may be considered a permanent solution.

The capital cost estimate for implementation of this alternative includes the costs of delineation of the extent of contamination in the wetlands, the excavation and relocation of sludge and wetland soils, the construction of the cap and engineering and administration. The annual cost includes environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 5A are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.8 Alternative 5B: Excavation, Relocation, and Covering with Geomembrane Cap

This is similar to Alternative 5A, except for the addition of a geomembrane layer to reduce the infiltration of precipitation. The items discussed for Alternative 5A apply to this alternative, also.

The estimated costs for implementing Alternative 5B are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.9 Alternative 6A: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Soil Cap

Alternative 6A will be protective of human health and the environment. The sludge and wetland soil will be excavated and treated on-site using solidification/stabilization. After the stabilization of the sludge and wetland soil material, it will spread in the landfill and covered using a soil cap. Capping would reduce the leaching of COCs to the groundwater and surface water, and minimize the potential of migration of COCs to off-site receptors. Capping would also reduce the potential for contaminants to come into contact with humans and animals and would reduce erosion. The interceptor trench would eliminate further leaching of COCs to groundwater by eliminating the contact of the water table with landfilled materials. It is possible that the installation of the cap will have the same effect.

This alternative is mostly in compliance with the NYS-SCGs, but does not provide a barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and erosion, may be associated with removal, treatment, and cap installation. Proper implementation of a site-specific health and safety plan (HASP) would mitigate risks associated with construction operations. Standard dust control measures would control exposure to workers during construction. This alternative is effective in containing the COCs in the long-term and may be considered as a permanent solution.

This alternative would not reduce the toxicity or volume of contaminated media, but it will reduce the mobility of COCs through the use of stabilization/solidification and capping. On-site treatment and construction of the cap is not expected to involve any implementation problem. The installation of the interceptor trench may encroach on property controlled by Conrail, Niagara Mohawk, and/or Sprint. The necessity for easements may provide administrative problems for implementation, and the assurance of structural integrity for the adjacent railroad tracks may provide technical limitations on implementability.

The capital cost estimate for implementation of this alternative includes the costs of delineation of the extent of contamination in the wetlands, the treatment of excavated sludge and wetland soil, construction of the cap, engineering and administration. The annual cost includes environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 6A are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.10 <u>Alternative 6B: Installation of Interceptor Trench, Excavation, On-Site Treatment, Relocation, and Covering with Geomembrane Cap</u>

This is similar to Alternative 6A, with the exception of the use of a geomembrane layer in the cap to reduce infiltration of precipitation. The items discussed for Alternative 6A applies to this alternative , also. The geomembrane layer will be the barrier layer required by Part 360.

The estimated costs for implementing Alternative 6B are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.11 Alternative 7A: Installation of Interceptor Trench, Excavation, Relocation, and Capping with Soil Cover

Alternative 7A will be protective of human health and the environment. The sludge and wetland soil are excavated and spread in the landfill without treatment. The landfill would then capped using a soil cap.

Capping would reduce the leaching of COCs to the groundwater and surface water and will minimize migration of COCs to off-site receptors. Capping would also reduce the potential for contaminants to come into contact with humans and animals and would reduce erosion. The interceptor trench would eliminate further leaching of COCs to the wetland.

This alternative is mostly in compliance with the NYS-SCGs, but does not provide a barrier layer required by Part 360. During implementation, moderate short-term impacts, such as fugitive emissions, human contact, and soil erosion, may be associated with excavation, grading, and cap installation. Proper implementation of a site-specific HASP would mitigate any risks associated with construction operations. Standard dust control measures and proper protection would control exposure to workers during construction.

This alternative would not reduce the toxicity or volume of contaminated media. It will reduce the mobility of the COCs by placing the contaminated media below a cap.

This alternative is similar to Alternative 6A, except that the sludge and wetland soil will not be chemically treated before being placed in the on-site landfill. There is not a measurable benefit to treatment of the sludge and wetland soils since the COCs are relatively immobile metals and capping will minimize the possibility of leaching metals into groundwater or transport by surface-water run-off.

This alternative is implementable and effective in containing the COCs in the long-term and may be considered a permanent solution.

The capital cost estimate for implementation of this alternative includes the costs of delineation of the extent of contamination in the wetlands, the excavation and relocation of sludge and wetland soils, the construction of the cap and engineering and administration. The annual cost includes environmental monitoring and maintenance of the cap. The estimated costs for implementing Alternative 4A are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

4.2.12 Alternative 7B: Installation of Interceptor Trench, Excavation, Relocation, and Covering with Geomembrane Cap

This is similar to Alternative 7A, except for the addition of a geomembrane layer to reduce the infiltration of precipitation. The items discussed for Alternative 7A apply to this alternative, also.

The estimated costs for implementing Alternative 7B are given in Table 4-2. The cost breakdown for this alternative is provided in Appendix B.

5. COMPARATIVE ANALYSIS OF ALTERNATIVES

This section describes the relative effectiveness of each alternative with respect to the evaluation criteria described in Section 4.1 (Evaluation of Remedial Alternatives). The alternatives are compared qualitatively, and substantive differences are identified between them.

5.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 does not contribute to the protection of human health and the environment. Alternative 2 provides a limited degree of protection of human health and the environment. Alternative 3A and 3B provides adequate protection of human health and limited protection to the environment. The alternatives 4A through 5B provide adequate protection of human health and the environment. The remaining alternatives 6A through 7B provide adequate protection of human health and increased protection to the environment.

5.2 COMPLIANCE WITH NYS-SCGS

All alternatives, except Alternatives 1, 2, 3A, and 3B can be designed and implemented to satisfy the NYS-SCGs

Except for the barrier layer requirements of 6 NYCRR Part 360, the relevant requirements set forth in the NYS-SCGs are satisfied by the capping Alternatives 4A through 7B. The capping Alternatives 4B, 5B, 6B, and 7B satisfy relevant requirements set forth in the NYS-SCGs, including the geomembrane barrier layer requirements of 6 NYCRR Part 360.

5.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 does not prevent or reduce the magnitude of risk to human health or the environment. Alternatives 2, 3A, and 3B reduce the magnitude of risk to human health and the environment. However, these three alternatives cannot be considered as a permanent solution for the Site as the potential risks associated with the exposure of the COCs are not eliminated. These three alternatives will not be effective on a long-term basis in eliminating the existing potential risks associated with the Site.

Alternatives 4A through 7B are expected to mitigate the risks identified in the risk assessment. Installation of capping and removal of soils, sludges, and wetland soils effectively isolates the COCs from potential receptors, thereby greatly reducing the potential risks. Alternatives 4A, 4B, 6A, and 6B with treatment do not reduce risks substantially compared to Alternatives 3A, 3B, 5A, 5B, 7A, and 7B.

Alternatives 4A through 7B can be considered a permanent solution as the potential risks associated with exposure to the COCs are eliminated. These alternatives will be effective in eliminating the potential risks associated with the Site on a long-term basis.

Groundwater monitoring is proposed for the balance of the monitoring period.

5.4 SHORT-TERM EFFECTIVENESS

Alternative 1 is the most effective in the short-term since it results in no site disturbance. Because there is no construction activity, there is no exposure to site contaminants related to short-term activities. Alternative 2 is similar to Alternative 1, except for the installation of the remaining fencing to provide access restrictions. These two alternatives best protect both the community and workers in the short term.

Alternatives 3A through 7B will result in significantly greater site disturbance compared to the previous alternatives. The grading, excavation, and cap installation activities will result in the need for mitigation activities to reduce air emissions and dermal contact with COCs. These alternatives will require heavy equipment for earth moving during remedial action and will have an increased potential for work-related accidents. The use of a site-specific HASP will minimize the risk of any on-site accidents. Exposure risks will be mitigated through the use of personal protective equipment.

The short-term impacts on the environment include construction traffic and an increase in noise level during construction. Air monitoring will be performed during site remediation activities to evaluate emissions. Proper dust control measures will be required to minimize particulate emissions.

5.5 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

The reduction of toxicity, mobility, or volume of the COCs varies between the alternatives evaluated. Alternatives 1 and 2 provide no reduction in the toxicity, mobility, or volume of COCs in the media, except through natural attenuation. Alternatives 3A through 7B reduce the mobility of COCs via a cap. In addition, Alternatives 6A through 7B will eliminate further mobility due to possible groundwater flow through the fill material.

Alternatives 4A, 4B, 6A, and 6B, which involve the stabilization/solidification of contaminated sludge and wetland soil and the installation of a cap, reduce the mobility by reducing the solubility of the COCs. Significant reduction of precipitation infiltration will minimize potential surface-water and groundwater contamination. The stabilization/solidification will marginally increase the volume of the stabilized material.

Alternatives 3A, 3B, 5A, 5B, 7A, and 7B, which involve the placement of contaminated sludge and wetland soil in the landfill without treatment, and installation of a cap, also reduce the mobility of the COCs, similar to Alternatives 4A, 4B, 6A, and 6B. During implementation of Alternatives 4A through 7B, excavating wetland soil runs the risk of resuspension and migration of COCs by intermittent surface water.

5.6 IMPLEMENTABILITY

Alternative 1 involves no remedial measures; therefore, implementability is not an issue. Alternative 2 involves little activity at the Site and, thus, implementability is not an issue for this alternative either.

For Alternatives 4A, 4B, 6A, and 6B, on-site solidification/stabilization can be implemented with little difficulty. The construction of a cap and relocation of wetland soils would require conventional construction equipment and techniques. This construction would require control to prevent release during excavation for Alternatives 3A through 7B.

The services, equipment, and material required to successfully implement any of the alternatives are readily available in the area. Numerous contractors are available to obtain competitive bidding for the work related to any of these alternatives.

Implementation of Alternatives 3A through 7B involves a degree of institutional administration as well. Local law enforcement agencies may be enlisted to perform visual inspection, on a periodic basis, to ensure the integrity of the security fence. Significant long-term management of an inspection and maintenance program to ensure the integrity of the cap would be required. The use of the Site will have to be restricted Implementation of an upgradient interceptor trench (Alternatives 6A, 6B, 7A, and 7B) may have implementability problems related to obtaining easements and maintaining the structural integrity of the adjacent railroad tracks.

5.7 COSTS

Cost estimates were developed for each of the alternatives The construction and O&M costs for each alternative were estimated conservatively.

The details of the estimated cost are presented in Appendix B The present worth of costs associated with each alternative were calculated using a discount rate of 7 percent for a 30-year time period. The estimated present-worth cost for each of the alternatives is as follows:

Alternative 1: $316,000

Alternative 2: $385,000

Alternative 3A: $1,172,000

Alternative 3B: $1,148,000

Alternative 4A: $2,454,000

Alternative 4B: $2,763,000

Alternative 5A: $1,242,000

Alternative 5B: $1,550,000

Alternative 6A: $2,559,000

Alternative 6B: $2,868,000

Alternative 7A: $1,347,000

Alternative 7B: $1,655,000

5.8 COMMUNITY ACCEPTANCE

The community acceptance of each alternative will be evaluated after a public hearing on the FFS. Geraghty & Miller anticipates that all of the alternatives, except Alternatives 1 and 2, will be acceptable to the community.

6. RECOMMENDED ALTERNATIVE

Following the analysis of the eleven potential remedial alternatives for the Site, Geraghty & Miller recommends that Alternative 7B be implemented as the remedial action. Alternative 7B provides the best balance of the evaluation criteria and satisfies applicable and relevant 6NYCRR Part 360 requirements including the requirement of a barrier layer in the capping.

Alternative 7B is protective of human health and the environment by ensuring that current risks are eliminated in the future. This is accomplished by installation of interceptor trench, excavation of sludge and wetland soils, and excavation of fill containing COCs beyond the capping area; relocation of excavated material in the on-site landfill; grading of the landfill to obtain the necessary slopes required by the regulations; and capping the landfill. It is possible that capping of the landfill may lower the water table locally to ensure that there is no contact with landfilled materials. A decision on the necessity for installation of the interceptor trench should be made on the basis of additional ground water elevation and quality measurements, and a water balance (performed during the remedial design phase); the preparation of the water balance may entail the installation of a limited number of piezometers. Gas vents consisting of PVC piping will be installed in the capped portion of the landfill. The china fill material already in place will serve as the gas venting layer.

This alternative will have a high degree of short-term effectiveness, as well as providing long-term effectiveness and implementable with moderate cost. Even though the alternative does not reduce the toxicity and volume of contaminated media, it reduces the mobility of the COCs significantly and eliminates the risks associated with the Site.

TABLES

Table 1-1. Summary of the Dissolved Metals Concentrations in Groundwater Exceeding the New York State Department of Environmental Conservation Division of Water Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values, Syracuse China Site, Syracuse, New York.

	TOGS 1.1.1 Standard	MW-1	MW-2	MW-3	MW-4	MW-4I	MW-5	MW-6	MW-7
Iron	0.3	--	--	1.12	--	106 J	0.72	7.44	2.34
Mangnesium	35*	--	51.4	44.3	--	165	--	--	--
Manganese	0.3	--	0.65	0.55	1.6	4.4 J	--	0.46	1.97
Sodium	20		41	29.3	36	25.9	69.5	--	32.9
Zinc	0.3	--	--	--	--	3.78 J	--	--	--

Concentrations reported in milligrams per liter (mg/L).
* Guidance value.
-- Standard not exceeded.

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Table 1-2. Summary of the Total (Unfiltered) Metals Concentrations in Groundwater Samples Collected on January 5, 1995, Exceeding the New York State Department of Environmental Conservation Division of Water Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values, Syracuse China Site, Syracuse, New York.

Parameter	TOGS 1.1.1 Standard	MW-1 1/5/95	MW-2 1/5/95	MW-3 1/5/95	MW-3 (Duplicate) 1/5/95	MW-4 1/5/95	MW-4I 1/5/95	MW-5 1/5/95	MW-6 1/5/95	MW-7 1/5/95
Arsenic	0.025	--	--	0.049	0.062	0.027	0.027	--	0.043	--
Copper	0.2	--	--	--	--	--	--	--	0.356	--
Iron	0.3	20.7	20.9 J	70.2 J	81.4	95.8 J	85.2 J	9.89 J	139 J	17.2 J
Lead	0.025	--	--	0.176	0.254	0.051 J	--	--	0.066	0.216
Magnesium	35*	74.6	82.2	206	199	99.4	157	45.8	221	37.2
Manganese	0.3	0.77	2.28	3.46	3.39	38.2	3.92 J	--	4.21	2.53
Sodium	20	22.3	1,020	32.6	32.8	38.9	25.5	71.6	--	33.6
Vanadium	0.014	--	0.24 B	0.074	0.075	0.088	0.074 J	--	0.109	--
Zinc	0.3	--	--	--	--	--	--	--	0.461	--

Concentrations reported in milligrams per liter (mg/L).
B Analyte results between instrument detection limit (IDL) and contract required detection limit (CRDL).
J Estimated value.
-- Standard not exceeded.
* Guidance value.

Table 1-3. Summary of Total (Unfiltered) Metals Concentrations in Groundwater Samples Collected on August 17, 1995, Exceeding the New York State Department of Environmental Conservation Division of Water Technical and Operational Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values, Syracuse China Site, Syracuse, New York.

Analyte	Sample Location: / Sample Date:	MW-1 8/17/95	MW-2 8/17/95	MW-3 8/17/95	MW-4 8/17/95	MW-4I 8/17/95	MW-5 8/17/95	MW-6 8/17/95	(MW-6 Rep) Rep-1 8/17/95	MW-7 8/17/95
Arsenic		--	--	0.107	--	0.0413	-	0.0276	0.0356	--
Copper		--	--	--	--	0.236	--	0.276	0.260	--
Iron		3.35	10.9	126	3	117	1.89	85.1	95.5	17.8
Lead		--	--	0.213	--	0.0991	--	0.0565	0.0569	0.292
Magnesium		41.5 J	70.4 J	207 J	--	174 J	--	158 J	179 J	53.4 J
Manganese		--	1.51 J	3.47 J	5.72 J	4.57 J	--	2.79 J	3.08 J	1.45 J
Sodium		--	51.6 J	43.5 J	40.4 J	30.7 J	68 J	--	21.7 J	38.3 J
Vanadium		--	0.0161 B	0.093	--	0.0967	--	0.0569	0.0581	0.0189 B
Zinc		--	--	--	--	0.419	--	0.342	0.342	--

Concentrations reported in milligrams per liter (mg/L).
B Analyte results between IDL and contract required detection limit (CRDL).
J Estimated.
-- Standard not exceeded.

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Table 4-1. Comparison of Alternatives and Evaluation Criteria, Syracuse China Site Landfill, Syracuse, New York.

	Alternatives											
Evaluation Criteria	1	2	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B
1. Overall protection of human health and the environment	No	Partially	Mostly Yes	Mostly Yes	Mostly Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Compliance with NYS-SCGs	No	No	Mostly	Mostly	Mostly	Yes	Mostly	Mostly	Yes	Yes	Mostly	Yes
3. Long-term effectiveness and permanence	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Short-term effectiveness	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Reduction in toxicity, mobility, or volume	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Implementability	Easily implementable	Readily implementable	Implementable	Implementable	Implementable with little difficulty	Implementable with little difficulty	Implementable	Implementable	Implementable with little difficulty	Implementable with little difficulty	Implementable	Implementable
7. Cost	Low	Low	Moderate	Moderate	Expensive	Expensive	Moderate	Moderate	Expensive	Expensive	Moderate	Moderate
8. Community acceptance.	Uncertain	Uncertain	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

NYS-SCGs New York State Standards, Criteria, and Guidelines.

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Table 4-2. Summary of Costs for Alternatives, Syracuse China Site L.

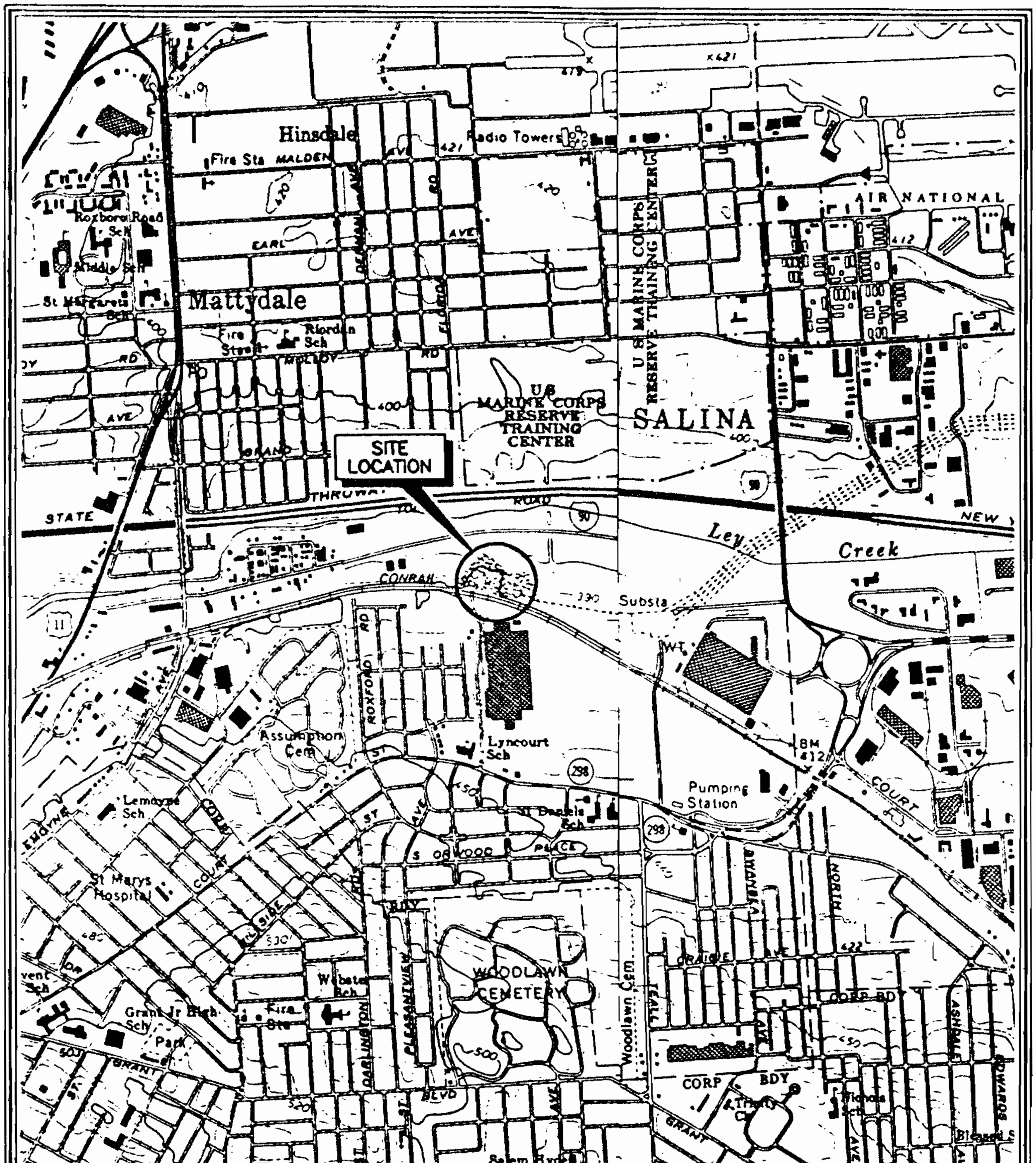
Alternative	Capital Cost	Annual O&M Cost	PW Annual	
Alternative 1	$0	$25,500	$316,430	$316,430
Alternative 2	$75,000	$25,000	$310,225	$385,225
Alternative 3A	$849,000	$26,000	$322,634	$1,171,634
Alternative 3B	$1,157,000	$26,000	$322,634	$1,479,634
Alternative 4A	$2,131,000	$26,000	$322,634	$2,453,634
Alternative 4B	$2,440,000	$26,000	$322,634	$2,762,634
Alternative 5A	$919,000	$26,000	$322,634	$1,241,634
Alternative 5B	$1,227,000	$26,000	$322,634	$1,549,634
Alternative 6A	$2,236,000	$26,000	$322,634	$2,558,634
Alternative 6B	$2,545,000	$26,000	$322,634	$2,867,634
Alternative 7A	$1,024,000	$26,000	$322,634	$1,346,634
Alternative 7B	$1,332,000	$26,000	$322,634	$1,654,634

Present-worth computations are based on an interest rate of 7 percent over a period of 30 years.

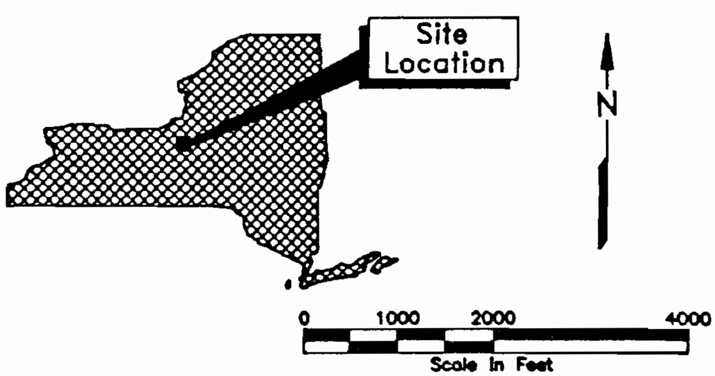
O&M Operation and maintenance.

PW Present worth.

FIGURES



Reference: U.S. Geological Survey, 7.5 Minute Quadrangle, Syracuse East(1977),Syracuse West(1978), New York



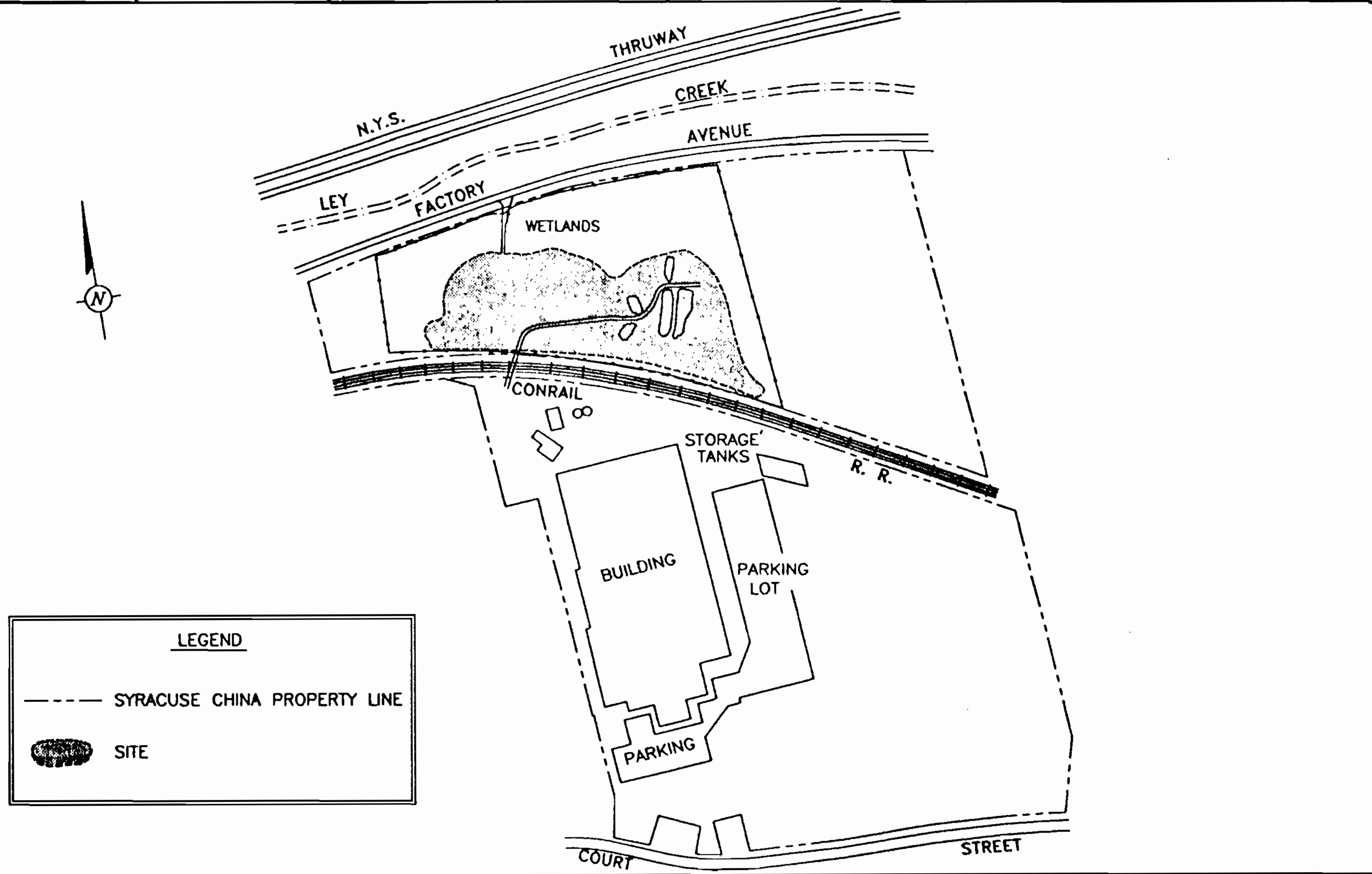
SITE LOCATION

SYRACUSE CHINA SITE LANDFILL
SYRACUSE CHINA COMPANY
Syracuse, New York

DRAWN: TAD CORP.	DATE:	FIGURE 1-1
APP'D:	APRIL 1993	

GERAGHTY & MILLER, INC.
Environmental Services

DATE: 11/15/95	PRJCT. NO.: AY0146001	FILE NO.:	CAD FILE: G130A	COMPILER: K. SELVAKUMAR	MGR.: K. SELAVKUMAR	DRAFTER: TAD/VC



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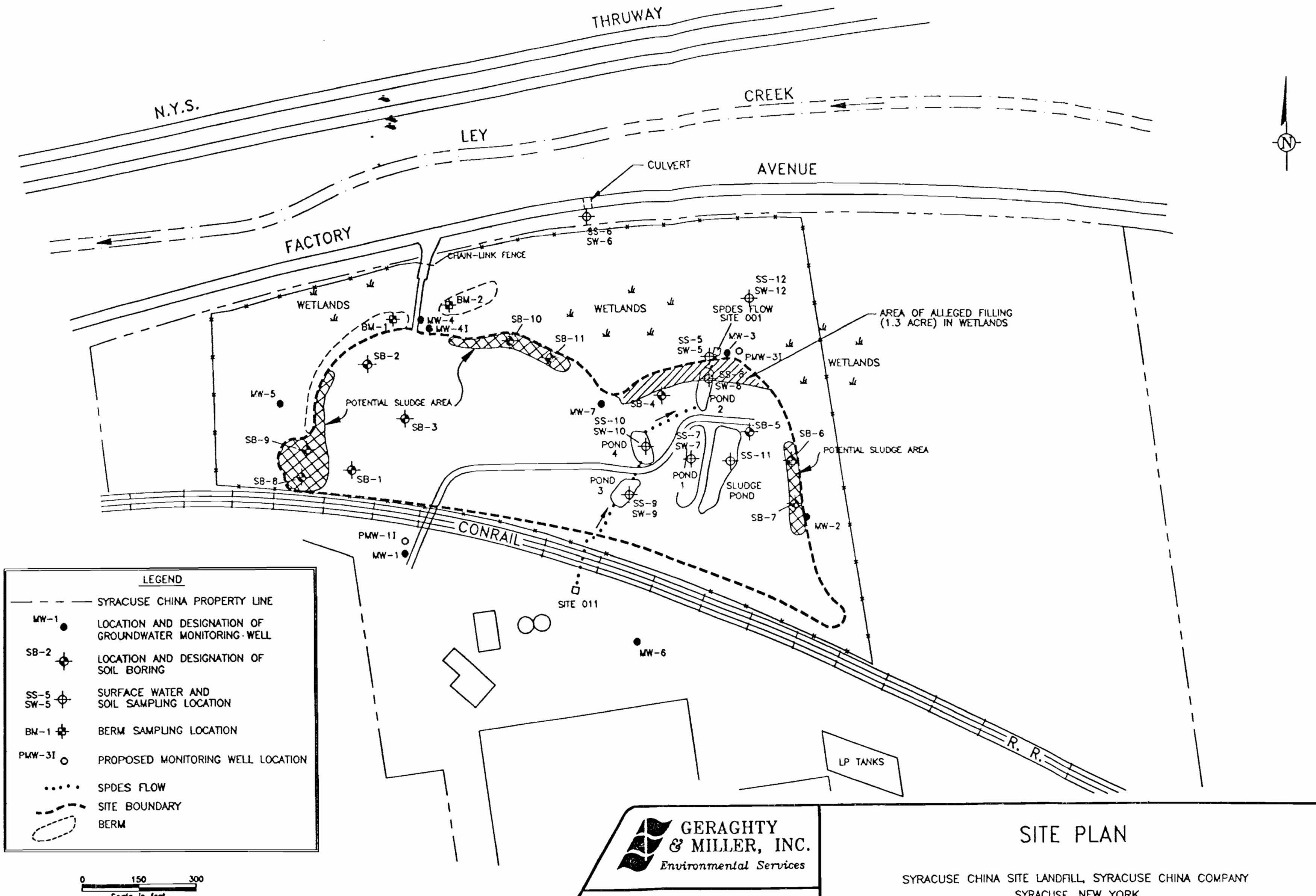
Environmental Services

LOCATION OF SYRACUSE CHINA SITE LANDFILL

SYRACUSE CHINA SITE LANDFILL, SYRACUSE CHINA COMPANY
SYRACUSE, NEW YORK

FIGURE 1-2



GERAGHTY & MILLER, INC.
Environmental Services

FIGURE 1-3

SITE PLAN

SYRACUSE CHINA SITE LANDFILL, SYRACUSE CHINA COMPANY
SYRACUSE, NEW YORK

DWG DATE: 1/15/95 | PRJCT NO.: AY0146002 | FILE NO.: - | DRAWING: GI26BB | CHECKED: K. SELVAKUMAR | APPROVED: K. SELVAKUMAR | DRAFTER: TAD\VC

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Figure 2-1

Screening of Remedial Technologies and Process Options for Soil, Sediment, and Sludge

Syracuse China Site Landfill, Syracuse China Company
Syracuse, New York

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost	Comments
No Action	None	Not Applicable	No action and perform environmental monitoring.	Not effective and does not achieve RAOs.	Readily implementable	Very low	Retained for alternative development
Limited Action	Access Restrictions	Fencing	Prevent trespassers and access to public. Maintain existing fence.	Partially effective and does not achieve all RAOs.	Readily implementable	Very low	Retained as a component in remedial alternatives
Containment	Vertical Barriers	Slurry Wall	Trench to required depth and fill with soil (or cement) bentonite slurry.	Effective and reliable.	Difficult to implement	High	Not retained
		Interceptor Trench	Excavate trench and backfill with permeable material.	Effective.	Implementable	Low	Retained
	Capping	Soil Cover	Cover the area with compacted soil and vegetation.	Effective and reliable.	Easy to implement	Low capital cost, moderate O&M cost	Retained
		Asphalt Cap	Cover the area with asphalt capping.	Effective, susceptible to weathering and cracking.	Easy to implement	Low capital cost, moderate O&M cost	Retained
		Geomembrane Cap	Cover the area with geomembrane, compacted protective soil layer, and vegetation.	Effective and highly reliable.	Easy to implement	Low capital cost, moderate O&M cost	Retained
In-Situ Treatment	Thermal Treatment	Vitrification	Electrical melting of soil to bind COCs in a solid glass matrix resistant to leaching.	Potentially effective for non-volatile metals. Potential adverse impact to process with volatile metals (ie. Pb).	Difficult to implement	High	Not retained
	Physical/Chemical Treatment	Solidification/Stabilization	Application of stabilization reagents and additives into subsurface soil using specialized machinery.	Effective.	Difficult to implement	High	Not retained
Removal	Excavation	Machine Excavation	Physically remove contaminated soil, sludge and sediments.	Effective.	Implementable	Medium	Retained
Treatment On-Site	Thermal Treatment	Rotary Kiln Incineration	Controlled, high temperature combustion.	Not effective for metals.	Difficult to implement	High	Not retained
	Physical/Chemical Treatment	Solidification/Stabilization	Application of stabilization reagents and additives and mix in containers..	Effective.	Difficult to implement	High	Retained
Disposal	On-Site Disposal	Spreading in the on-site landfill	Placement of treated or untreated soil in the landfill before capping.	Effective.	Easy to implement	Low	Retained
	Off-Site Disposal	Landfill	Placement of excavated soil in a permitted landfill.	Effective in isolating COCs.	Implementable	Very high	Not retained

Legend

General response actions, remedial technologies and process options that have not been selected for remedial action.

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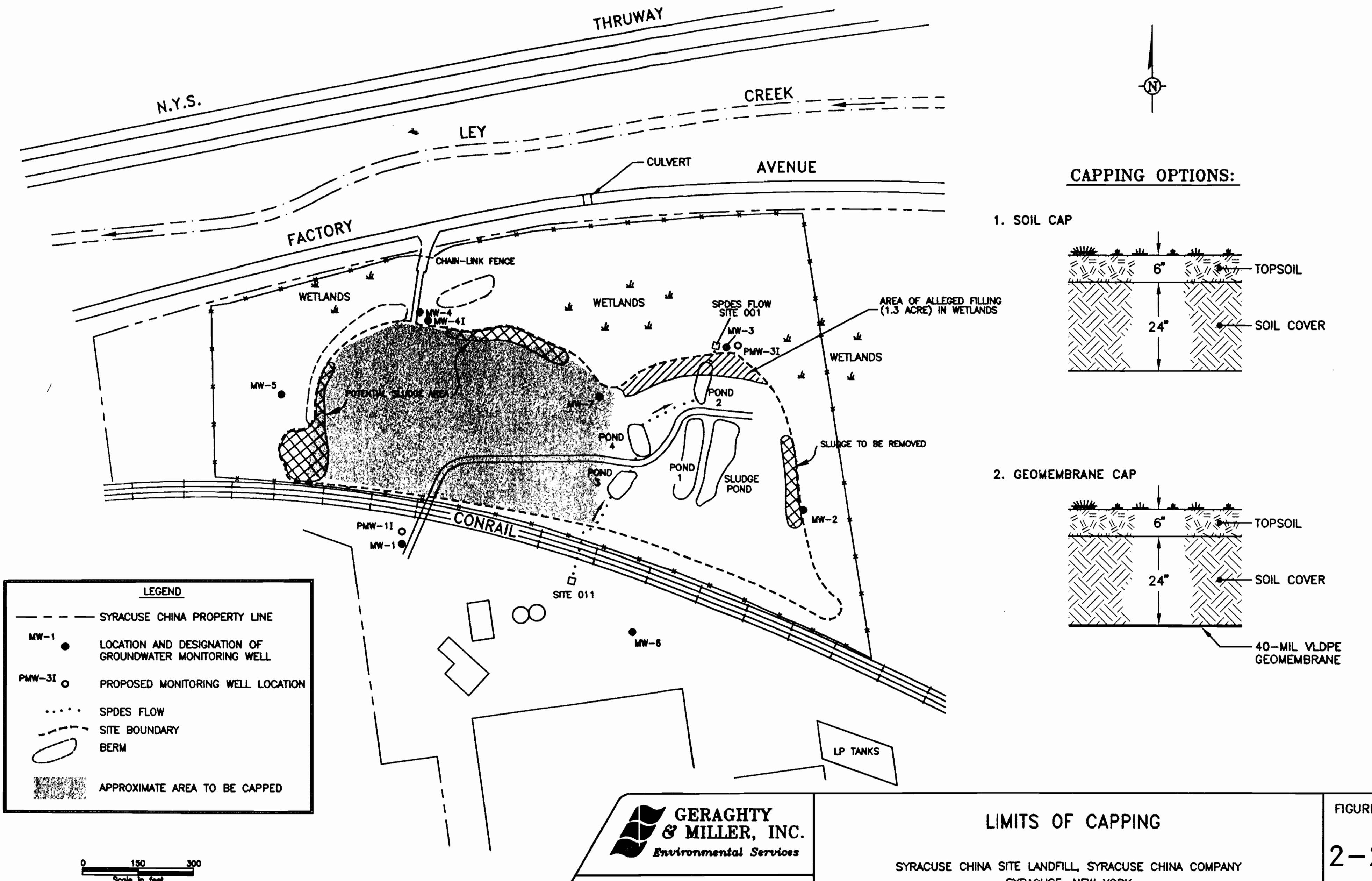


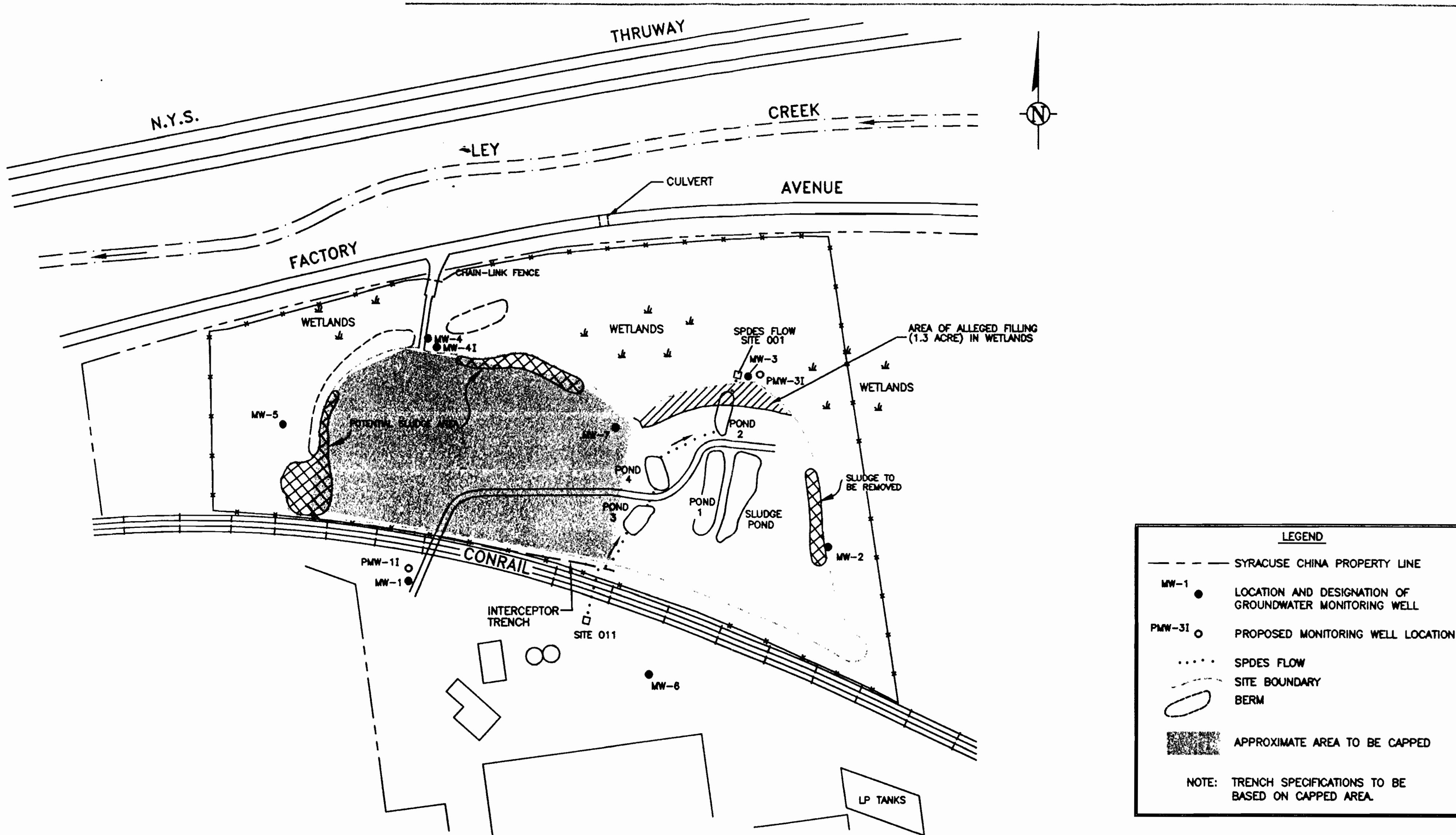
GERAGHTY & MILLER, INC.
Environmental Services

LIMITS OF CAPPING

SYRACUSE CHINA SITE LANDFILL, SYRACUSE CHINA COMPANY
SYRACUSE, NEW YORK

FIGURE
2-2

FOIL065292



0 150 300
Scale in feet

GERAGHTY & MILLER, INC.
Environmental Services

LOCATION AND EXTENT OF INTERCEPTOR TRENCH

SYRACUSE CHINA SITE LANDFILL, SYRACUSE CHINA COMPANY
SYRACUSE, NEW YORK

FIGURE 3-1

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APPENDIX A

APPENDIX A

POTENTIAL EXPOSURE PATHWAYS

SYRACUSE CHINA WETLANDS

File

Nixon, Hargrave, Devans & Doyle LLP

Attorneys and Counselors at Law

CLINTON SQUARE
POST OFFICE BOX 1051
ROCHESTER, NEW YORK 14603-1051
(716) 263-1000
FAX (716) 263-1600

ONE KEYCORP PLAZA
ALBANY, NEW YORK 12207
(518) 427-2650

1600 MAIN PLACE TOWER
BUFFALO, NEW YORK 14202
(716) 853-8100

990 STEWART AVENUE
GARDEN CITY, NEW YORK 11530
(516) 832-7500

437 MADISON AVENUE
NEW YORK, NEW YORK 10022
(212) 940-3000

SUITE 700
ONE THOMAS CIRCLE
WASHINGTON, D.C. 20005
(202) 457-5300

WRITER'S DIRECT DIAL NUMBER:
(716) 263-1606

INTERNET:
lford@nhdd.com

December 21, 1995

Steven Scharf
New York State Department
of Environmental Conservation
Bureau of Hazardous Site Remediation
50 Wolf Road
Albany, New York 12233-7010

RE: Syracuse China - Ecological Risk-Based Lead Target Soil Cleanup Number

Dear Steve:

As we discussed on Monday, enclosed please find a draft White Paper entitled "Potential Exposure Pathways - Syracuse China Wetlands" prepared by Cathie Baumgartner and Terrestial Environmental Specialists, Inc. This draft pathway analysis indicates that, based upon a review of literature, and a knowledge of existing site conditions, a lead cleanup goal in the wetlands of 1300 ppm does not result in a hazard index greater than one for any of the pathways analyzed. Even if the remedial work in the wetlands significantly improves the wetland as a habitat or feeding area, a lead cleanup level between 1,100 and 1,300 will be protective of wildlife. In accordance with our discussions I'm also faxing a copy of this directly to Richard Koeppicus.

As we discussed at our November 16, 1995 meeting, we suggest that this level become the initial target cleanup level. However, as we also discussed at that meeting, as part of the remedial design phase, a more detailed sampling and analyses for lead within the wetlands will be undertaken. Based upon the results of that screening a "defacto background level" may emerge. If that defacto background level is higher than the ecological risk number, then the background number would become the target cleanup number. Finally, as we also discussed at the November meeting, we would like to retain the right after the additional data on lead levels in the wetland are collected and evaluated, to do a site-specific risk assessment to set a site-specific lead cleanup number. However, for purposes of the

Nixon, Hargrave, Devans & Doyle LLP

Feasibility Study and moving the project forward, we propose, based upon the attached pathway analysis, an initial target cleanup number of 1100 ppm for lead within the wetlands. This target cleanup number would be adjusted only in the event that subsequent data is submitted to the Department, and the Department is satisfied that the data supports an increase in the target cleanup number.

As always, if you have any questions, please do not hesitate to call me.

Very truly yours,

Libby Ford

Libby Ford, QEP, Senior
Environmental Health Engineer

Enclosure
cc: Andy Barber (with enclosure)
Cathie Baumgartner (with enclosure)
Rob McEwan (with enclosure)
Ed Jackson (with enclosure)
Phil Harvard (with enclosure)
Elaine Bobletz (with enclosure)

POTENTIAL EXPOSURE PATHWAYS - SYRACUSE CHINA WETLANDS

INTRODUCTION

The following is a simple risk analysis using three potential wildlife exposure pathways for contaminants in that portion of DEC regulated wetland SYE-6 that is on the Syracuse China property in Syracuse, New York. The contaminant of concern in the soil is lead. Contaminated soil from this wetland will be excavated and consolidated in the onsite landfill outside of the wetland as part of the remedial activities. Current contaminant levels in the wetland soils range from 2.3 ppm to 5,110 ppm. The objective of this analysis is to determine a cleanup level for lead in the soil that will result in an acceptable risk to resident and migratory wildlife that may use this wetland. Therefore, Hazard Index values for several potential wildlife exposure pathways in the existing wetland were calculated using various soil contaminant levels. The results of these calculations are presented in Table 1. As an illustration, the following is a description of the pathways, and the calculations for a contaminant level of 1,300 ppm of lead.

STUDY AREA

Approximately 12 acres of Wetland SYE-6 are present on the Syracuse China property adjacent to the landfill. Surrounding land use/vegetation cover consists of residential/commercial/industrial uses on the south and west of the site, and various wetland and upland vegetation types to the east and northeast.

The wetland is a mixture of vegetation cover types, but is primarily emergent wetland and scrub-shrub wetland with a small area of deciduous forest wetland.

The emergent wetland is dominated by common reed (*Phragmites australis*). This community type also contains common cattail (*Typha latifolia*) and purple loosestrife (*Lythrum salicaria*). The scrub-shrub wetland is dominated by willow (*Salix* sp.), silky dogwood (*Cornus amomum*), and gray dogwood (*Cornus foemina*) in the shrub layer. A few scattered gray birch (*Populus deltoides*) occur in these areas as well. Common reed dominates the herbaceous layer of the scrub-shrub wetland.

PATHWAY ANALYSIS

In order to determine a cleanup criterion to be used in excavation of the lead contaminated soils in this wetland, several potential exposure pathways were considered. These exposure pathways include plants and animals that are known to be present in the

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wetland, or those that are likely to be present, based on our knowledge of local wildlife and habitat relationships in the central New York area. The following exposure pathways were analyzed:

Soil → Earthworm → Woodcock

Soil → Cattail → Muskrat

Soil → Weed seed → Red-winged Blackbird

Lead toxicology and contamination have been studied extensively. Lead is known to concentrate in the organic-rich surface horizons of soil. Lead concentrates in plant structures in approximately the order **roots >> stems > leaves >> seeds**. The uptake of lead by plants from soils of high pH is much reduced. Lead is not very toxic to plants, with concentrations as high as 1000 ppm resulting in no measurable effect in some plants (EPA, 1983). There is no evidence of food chain biomagnification of lead (EPA, 1980). Eisler (1988) recommended a maximum concentration for livestock forage of 200 mg/kg lead. The maximum allowable lead concentration in domestic animals (including cattle) was recommended at 30 ppm (NAS, 1980).

SPECIES/PATHWAY DESCRIPTIONS AND RISK ANALYSES

This section briefly describes the behavior, phenology, and feeding habits of the species listed above, and presents a preliminary risk analysis for each pathway.

Soil → Earthworm → Woodcock

Earthworms are short-lived invertebrates that not only are in constant contact with the soil, but which also ingest it as part of their feeding behavior. They generally remain in the upper few inches of soil.

Woodcock are a migratory, breeding species in central New York. While this species is not listed as breeding in the New York State Breeding Bird Atlas block in which the site is found, it is a common breeder throughout the state, and it is found in Atlas blocks adjacent to the one in which the site is found (Anderle and Carroll, 1988). This species feeds largely on earthworms (approximately 60% of its total diet according to Martin *et al.* (1951)). Sheldon (1971) reports it to "rely on earthworms" and Anderle and Carroll (1988) indicate the main habitat requirement for the species is an abundant supply of earthworms. For the purpose of this risk analysis, we considered earthworms to constitute 100% of the food eaten by woodcock. This is an overestimate.

We also assumed that woodcock feed 100% within the contaminated wetland. This is also undoubtedly an overestimate since woodcock feed in a variety of habitats (Anderle and Carroll, 1988; Martin *et al.* 1951; Sheldon, 1971, Wakeley and Wakeley, 1985) that are not necessarily wetlands. We could find no information concerning the size of an area used by woodcock for feeding during the breeding season.

Lastly, woodcock are migratory, arriving in March and ordinarily departing by November (Bull, 1985). Breeding and fledging dates are March through July (Anderle and Carroll, 1988), after which woodcock become more gregarious and may feed in areas distant from breeding habitat (Sheldon, 1971). For this reason, in the analysis, we considered woodcock to be feeding in the breeding territory for 6 months out of the year (50% of their feeding life). This is still probably an overestimate.

In a study of lead concentrations in earthworms, Beyer, *et al.* (1993) determined that the bioconcentration factor (**BCF**) for earthworms is **0.45**, which is the proportion of the lead in soil which is accumulated by earthworms. Also, he determined that approximately 50% of the lead concentration in earthworms is available to birds through a worm diet.

Assuming a 1,300 ppm concentration of lead in the soils at the site:

1,300 ppm X 0.45 = 585 ppm in earthworms

and:

585 ppm X 0.50 = 292.5 ppm available in the diet of birds

Applying the factor to account for any woodcock feeding on the site for 50% of its life cycle, chronic dietary exposure is estimated as follows:

292.5 ppm X 0.50 = 146.25 ppm

Beyer *et al.* (1988) determined that a chronic exposure of 150 ppm of lead in the diet of birds should be considered hazardous to bird survival. Using the hazard index **HI** of Menzie *et al.* (1992), we computed the index as follows:

HI = 146.25 ppm in diet / 150 ppm effect endpoint = 0.98

A hazard index greater than one would be cause for concern, while an index less than one would not. We conclude that a concentration of 1,300 ppm lead in the soil would not pose a significant hazard to woodcock, or other birds feeding primarily on earthworms on the site.

Soil → Cattail → Muskrat

Cattails are present in the emergent wetland cover type on the site, although this species only constitutes 5-10% of the herbaceous layer cover in the wetland. Cattail is a persistent, herbaceous species that grows in patches. Aboveground portions of the plant die in fall, but remain standing. In spring, plants generally sprout from root stock.

Muskrats are permanent residents of streams, marshes and other wetland areas. Dispersal occurs in the spring of the year. Evidence of muskrats using the site was not observed, but they are apparently present in and along Ley Creek.

Muskrats are primarily herbivores. Although some animal food (mollusks, crayfish, fish) is consumed, the percentage is very low (Martin *et al.* 1951). Cattails are a preferred food in the Northeast, and muskrat eat the stems, leaves, and rootstocks of this plant and other marsh plants throughout the year (Martin *et al.* 1951, Schwartz and Schwartz, 1981).

Muskrat home ranges are relatively small, and most of their activity apparently occurs within a radius of approximately 100 meters (330 feet) [(Chu and Yien 1962, Erickson 1963, Errington 1963, Neal 1968) in Dannel, 1978]. Since the on-site wetland is marginal habitat, we assumed that muskrats living along Ley Creek might access this wetland via the culvert under Factory Avenue and use it as an occasional foraging location. Therefore, for this analysis, we considered 25% of the muskrat diet to consist of plant material growing in the contaminated wetland.

Only a small portion of the lead in the soil is available for uptake by plants. Plant lead concentrations relative to soil concentrations have been determined as a soil-to-plant concentration factor **Bv** (Baes *et al.* 1984) which is expressed as:

$$\mathbf{Bv = Cv / Cs}$$

where **Cv** is the concentration in plant vegetative parts (roots, stems, leaves), and **Cs** is the concentration in the soil. Additionally, **Br** is a measure of the concentration factor in plant reproductive parts **(Cr)**, and is represented by:

$$\mathbf{Br = Cr / Cs}$$

The plant concentration factors for lead are given by Baes *et al.* (1984) as **Bv** = **0.045**, and **Br** = **0.009.**

Assuming again 1,300 ppm lead in the soil, the concentration expected in the vegetative portions of plants is given by:

1,300 ppm X 0.045 = 58.5 ppm lead in plants

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There is a great deal of variability in dose/response data for lead in the literature. Data on the acute survival of rodents (rats) was presented by Clark (1979) who found that lead concentrations of 100 mg/kg in the diet affected survival. However, some chronic effects were noted by Nriagu (1978) at concentrations of 25 mg/kg in the diet. Eisler (1988) presented the results of numerous studies and reported lead concentrations in the diet of rats which produced chronic effects at levels ranging from 1.5 mg Pb/l to 4,000 mg Pb/l. These chronic effects included potentially difficult to measure endpoints such as "disturbed sleep patterns", "growth retardation", "behavioral deficits" among others. Acute effects (deaths, LD50's, etc.) were also reported. The values ranged from 100 mg/kg BW of lead nitrate in the diet which caused "some deaths" to 2,000 mg Pb/l in drinking water, which showed no effect at all. EPA (EPA,1992) used a threshold intake level for lead of 150 μg-Pb/g-diet DW in their analysis of a soil→soil organisms→ bird/small mammal pathway.

In order to more objectively select dietary dose level for rats (applied to muskrats in this case) geometric means of the chronic effects and acute effects levels reported by Eisler (1988) were calculated. The numeric distribution of dose/response data is not normally distributed so the arithmetic mean would not be an accurate representation of central tendency. Such data has been shown to be log-normally distributed, so an appropriate log transformation is indicated (EPA, 1986). The geometric mean of a set of numbers is equal to the *n*th root of the product of *n* numbers, however in practice logs are used to perform the computation by transforming the numbers, calculating the mean of the transformed data, and then taking the antilog of the result. The resulting acute dietary effects endpoint was calculated as 256.4 ppm, and the chronic dietary effects endpoint obtained was 55.1 ppm.

Assuming that the muskrats obtained 25% of their diet on the site, and assuming rat data applies to muskrats, both acute and chronic hazard indices can be computed:

HI acute = 58.5 ppm in diet / 256.4 ppm endpoint x .25 = 0.06

and:

HI chronic = 58.5 ppm in diet /55.1 ppm endpoint x .25 = 0.27

Our very liberal estimate of dietary exposure of lead in muskrats on the site suggests that a concentration of lead in the soil of 1,300 ppm would not represent a significant hazard to these animals.

Soil → Weed seed → Red-winged Blackbird

A variety of herbaceous plant species are found in the Syracuse China wetlands and adjacent upland areas. Many of these species produce seeds that can be consumed by songbirds such as the red-winged blackbird.

Red-winged blackbirds are a common breeding species in New York and are listed in the New York State Breeding Bird Atlas block in which the site is found. Weed seeds and farm crops make up most of the diet (Martin *et al*, 1951) although it is reported to be largely insectivorous during its nesting season (Brauning, 1992). Martin *et al* (1951) report 60% plant food in spring, and 50% plant food eaten by this species in summer. Even when nesting in a marsh, red-winged blackbirds reportedly often forage in nearby fields (Brauning, 1992). Therefore, for this analysis we considered weed seeds from plants growing in the contaminated soils to constitute 50% of the species' diet. This is probably an overestimate.

Red-winged blackbirds are migrants, arriving in New York in March and completing breeding in July (Anderle and Carroll, 1988). After the breeding season is complete, red-winged blackbirds form flocks in late summer and fall, and migrate south. A few individuals overwinter in central New York. For this analysis, we considered the red-winged blackbird to be present on the site for 6 months of the year. Combining these factors we obtained 0.25 (.5 X .5) as the portion of their food which blackbirds obtain from the contaminated area.

Since this proportion of their food supply would consist of plant seeds obtained on the site, we use the **Br** of 0.009 (Baes *et al*, 1984) as the proportion of lead in soil which is actually accumulated in the seeds (reproductive parts).

Assuming again a 1,300 ppm concentration in the soil:

1,300 ppm X 0.009 = 11.70 ppm lead in plant seeds

and applying the feeding factors discussed above:

11.7 ppm seeds X 0.25 of diet = 2.93 ppm in diet

Using the 150 ppm chronic dietary exposure (Beyer *et al*, 1988) as an endpoint for lead in birds, a hazard index can be calculated as:

HI = 2.93 ppm diet / 150 ppm effect endpoint = 0.02

Considering the low rate of uptake of lead in plant reproductive parts, it is doubtful that seed eating birds would be adversely affected by 1,300 ppm concentration in the soil.

CONCLUSIONS

Based on the calculations illustrated above and summarized in Table 1, it appears that a target soil clean-up level of 1,300 ppm lead in the wetland will result in an acceptable risk to wildlife.

The EPA, in a human health risk assessment used a guidance value of 500-1,000 ppm of lead in soil using the Uptake Biokinetic Model and the model's default parameters (EPA 1991). The EPA, in a technical support document on land application of sewage sludge calculated a criteria limit for lead in soil of 2,525 ppm, and stated that no studies have been found in which wildlife exhibited toxic effects at that level (EPA, 1992).

EXPOSURE PATHWAYS - POST REMEDIATION

Remediation activities in the wetland will consist of excavation of soil to the agreed-upon criterion. This will alter the wetland habitat by decreasing the surface elevation, and perhaps by increasing the amount of surface water cover in the wetland. These physical changes alone could change the value of the wetland as habitat for the animals investigated in the potential exposure pathways. A possible habitat alteration scenario is discussed below.

If the wetland is altered to the extent that there is more surface water in it, common reed may be replaced as the dominant herbaceous plant by common cattail. This type of physical habitat will probably not be used by woodcock, because this species does not feed in these types of areas, and most likely there will be limited, if any, earthworms as a food source.

Red-winged blackbirds use cattail-dominated marshes, and in fact, this would probably be better nesting habitat than the existing marsh. However, the birds may have to forage for food in other habitats in the vicinity in order to find appropriate seed sources, therefore their exposure might be less than it is now.

Lastly, conversion of the existing wetland into a cattail-dominated emergent marsh might make this area much better muskrat habitat, to the extent that muskrats might take up permanent residence there and consume 100% of their diet from the wetland on-site, rather than 25% as was used in the risk analysis. In that case, the following hazard indices can be calculated for muskrats using various soil lead concentrations, and feeding in the wetland exclusively.

Lead Level (ppm)	Muskrat Hazard Index acute/chronic
100	0.02/0.08
300	0.05/0.25
500	0.09/0.41
700	0.12/0.57
900	0.16/0.74
1100	0.19/0.90
1300	0.23/1.06
2000	0.35/1.63
2500	0.44/2.04

Thus it can be seen that even if the wetland is altered to the extent that it provides better habitat for muskrats, a clean-up level of between 1,100 ppm and 1,300 ppm in the soil is still protective of this species.

TABLE 1
Calculated Hazard Indices for Existing Wetland Habitat

SOIL LEAD LEVELS (PPM)	HAZARD INDEX		
	Woodcock (chronic)	Muskrat (acute/chronic)	Red-winged Blackbird (chronic)
100	0.08	0.004/0.020	0.002
300	0.23	0.013/0.061	0.005
500	0.38	0.023/0.102	0.008
700	0.53	0.031/0.143	0.011
900	0.68	0.039/0.184	0.014
1100	0.83	0.048/0.225	0.017
1300	0.98	0.057/0.265	0.020
1500	1.13	0.066/0.306	0.023
2000	1.50	0.088/0.408	0.030
2500	1.88	0.110/0.510	0.038

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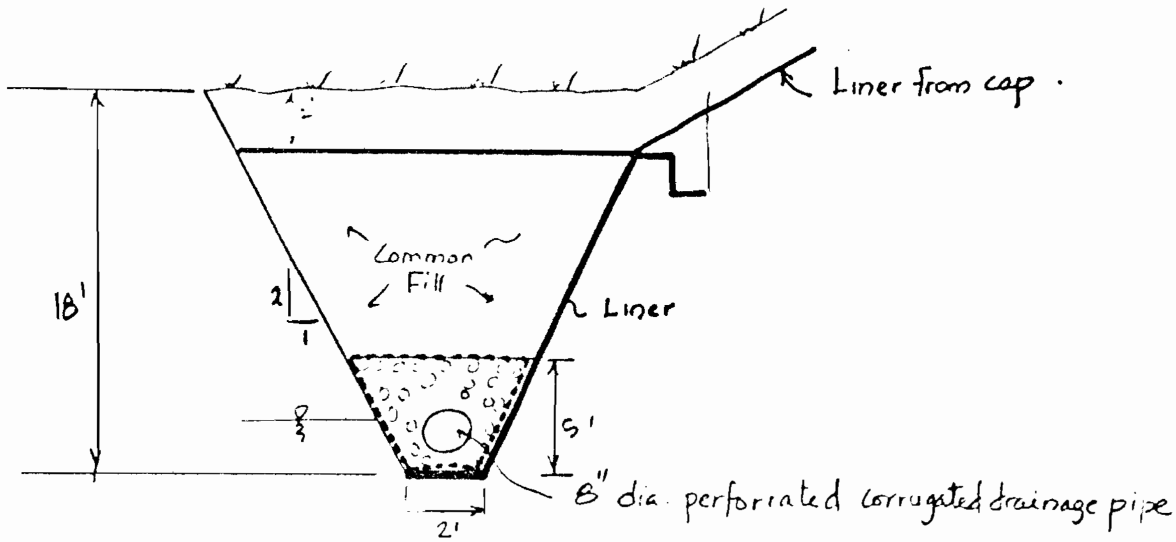
APPENDIX B

APPENDIX B

COST ESTIMATE DETAILS FOR ALTERNATIVES

Interceptor trench - Construction Cost
Syracuse China Site Landfill
Syracuse, New York

2/22/95 1 2
Kumar
NY026.002



Excavation = $\frac{1}{2}(2+20)(18)$ = 198 ft³/ft = 7.3 CY/ft

Stone = $\frac{1}{2}(2+7)(5) - \frac{\pi}{4}(1)^2(1)$ = 21.7 ft³/ft = 0.8 CY/ft

Commonfill = $\frac{1}{2}(7+20)(13)$ = 175 ft³/ft = 6.5 CY/ft

liner = $2 + 16\frac{\sqrt{5}}{2} + (6+2) + 3$ = 41 sq.ft/ft

Filter fabric = $2 + 7 + 2\left(\frac{5}{2}\sqrt{5}\right) + 3$ = 24 sq.ft/ft

pipe = 1 ft/ft

seeding = 17 ft²/ft.

Unit Cost

- 14'-20', 1 C.Y hydraulic backhoe — \$3.59 × 1.13 = \$4.10/CY — Use \$5/CY.
- Backfilling with commonfill — \$3/CY.
- 3/4 - 1" stone with placing — \$20/CY.
- 60 mil HDPE liner — \$0.75/sq.ft or \$6.75/SY.
- Fabric — \$0.30/sq.ft or \$2.70/SY.
- 8" perforated pipe — \$4.00/ft
- seeding — \$0.05/ft²

Interceptortrench - Construction Cost
Syracuse China Landfill
Syracuse, New York

12/22/95 2 2
Kumar
AY0146.002

Cost for Unit length of trench

Excavation	=	$7.30\frac{CY}{ft} \times \$5/CY$	=	\$36.50/ft
Liner	=	$41\ ft^2/ft \times \$0.75/ft^2$	=	\$30.75/ft
Fabric	=	$24\ ft^2/ft \times \$0.30/ft^2$	=	\$7.20/ft
Stone	=	$0.8\ CY/ft \times \$20/CY$	=	\$16.00/ft
Commonfill	=	$6.5\ CY/ft \times \$3/CY$	=	\$19.50/ft
Pipe	=	$1\ ft/ft \times \$4/ft$	=	\$4.00/ft
Seeding	=	$17\ ft^2/ft \times \$0.05/ft^2$	=	\$0.85/ft
				\$104.80

Say \$105/ft

Length of the interceptor trench = 800 ft

∴ Total Construction Cost = 800 x \$105 = \$84,000

Feasible Alternative - Cost Estimation
Syracuse China & ie Landfill
Syracuse, New York

5/18/95 1 9
KS
AY0146.015

Alternative 1: No Action

Assumptions:

- semi-annual groundwater monitoring.
- groundwater monitoring will consists of 10 monitoring wells.
- 5-year review.

Capital Cost

NONE

Operation & Maintenance Cost

1. GW monitoring event (10 monitoring wells)

Sampling	2 man days x 10 hrs/day x $80/hr	= $1600
Expenses		= $200
Analyses	11 nos @ $600/ea	= $6600
		$8400/event

Semi-annual monitoring cost = 2 x $8400 = $ 16,800 /Yr

2. Annual reporting to NYSDEC

Report preparation = $ 3000/Yr

3. 5-year Review
Report preparation $5000 = $ 1000/Yr

$20,400

Contingency 25% $ 5,100

$ 25,500

Alt. 1

Capital Cost	= $ 0
O&M Cost	= $ 25,500/Yr.

FOIL065315

Alternative 2: Limited Action.

Assumptions:

- Fencing (additional cost as the fencing is not compete)
- public education program.
- groundwater monitoring as in Alt. 1
- no 5year Review

except for the existing fencing south of Factory Avenue, the rest will be new fence

Capital Cost.

Fencing	3200' @ $15/ft	=	$ 48,000
Public Education Program implementation		=	$ 10,000
			$ 58,000
	contingency 25%		$ 14,500
			$ 72,500

Say $75,000/.

O&M Cost:

Same as in Alt. 1	=	$ 19,400
fence Maintenance	=	$ 600
		$ 20,000
Contingency 25%		$ 5,000
		$ 25,000 / Yr

Alt. 2

Capital Cost	= $ 75,000
O&M Cost	= $25,000/Yr

Perreas' Alternative - C.C. Estimation 1/18/96 3 ?
Kumar

Alternative 3A:

Cap Area = 8.5 Acres

6" vegetation — Top soil
24" Soil (on-site)

Assumptions:

- Fencing (add - no fence)
- excavation of sludge not wetland soils
- dewatering of sludge
- removal of fill from eastern portion and relocating
- grading the landfill to grade and slopes
- installation of soil cover
- drainage control structures
- no borrow soil (entire material to be from the site)
- Annual gw monitoring
-

Capital Cost

* Sludge volume = $0.71\ in^2 \times 230^2\ \frac{ft^2}{in^2} \times 5.6\ ft \times \frac{1}{27}\ \frac{cy}{ft^3}$ = 7790 CY
* Relocation from Eastern portion $240{,}000\ sq\ ft \times 3\ ft \times \frac{1}{27}\ \frac{cy}{ft^3}$ = 26,600 cy

1	Excavation (7790 + 26,600) CY @ $5/CY	= $172,000
2.	Dewatering sludge 7790 CY @ $2/CY	= $16,000
3.	Grading 14 Acr @ $1200/Acr	= $16,800
4	Installation of Protective layer $8.5 \times 43{,}560 \times \frac{2}{27}$ = 27,500 CY @ $6/CY	= $165,000
5.	Top soil $8.5 \times 43560 \times \frac{0.5}{27}$ = 6860 CY @ $20/CY	= $137,200
6.	Hydroseeding 8.5 Acr @ $2200/Acr	= $18,700
7.	Drainage Control structures 8.5 Acr @ $10,000/Acr	= $85,000
		$610,700
8.	Additional delineation sampling in wetland	$20,000
		$630,700

w/ 25% contingency $789,000

FOIL065317

Add Fencing Cost ($48,000 x 1.25 = $60,000) Total = $ 849,000

Alternative 3A:
O&M Cost:

Annual GW monitoring	=	$ 8,400
Fence maintenance	=	$ 600
Cap maintenance 8.5 Ac @ $1000/Ac	=	$ 8,500
Annual reporting	=	$ 3,000
		$ 20,500

w/ 25% contingency $ 26,000 / Yr

Alt 3A:

Capital Cost	= $ 849,000
O&M Cost	= $ 26,000/Yr

Alternative 3E:
Assumptions:
Same as in 3A, with additional geomembrane.

Capital Cost = $ 678,700
geomembrane 8.5 x 43,560 SF x $ 0.65/SF = $ 247,000

Total = $ 925,700

w/ 25% contingency = $ 1,157,000

O & M Cost:
Same as in 3A $ 26,000/Yr

Alt 3E: Capital Cost	= $ 1,157,000
O & M Cost	= $ 26,000/Yr

Alternative 4A

Assumptions • From (additional) factors

- Excavation of sludge & wetland soils
- dewatering of sludge & wetland soils
- removal & relocation of fill
- treatment of excavated sludge & wetland soils
- grading
- installation of soil cover
- drainage control structures
- Annual gw monitoring.

Capital Cost

* sludge volume = 7790 CY.
wetland soils (10 ft into wetlands) - 0.5 ft dredging thickness.
$2200 \times 10 \times 0.5 \times \frac{1}{27} = 410$ CY

∴ Total Volume = 8200 CY

* Relocation from Eastern portion = 26,600 CY

1.	Excavation (8200 + 26,600) CY @ \$5/CY	=	\$ 174,000
2	Dewatering 34,800 CY @ \$2/CY	=	\$ 70,000
3.	Onsite solidification $\frac{8200 CY}{1.1 t/CY}$ × \$130/t	=	\$ 970,000
4.	grading 14 Acr @ \$ 1200/Acr	=	\$ 16,800
5.	Installation of protective layer	=	\$ 165,000
6.	Top soil	=	\$ 137,200
7.	Hydroseeding	=	\$ 18,700
8.	Drainage control structures	=	\$ 85,000
			\$ 1,636,700
9.	Additional delineation sampling wetland		\$ 20,000
			\$ 1,656,700

w/ 25% contingency \$ 2,071,000
Existing Cost (\$ 48,000 x 1.25) \$ 60,000

FOIL065319

Total = \$ 2,131,000

Alternative 4A:

O&M Cost:

Annual gw monitoring	=	$ 3,400
Fence maintenance	=	$ 600
Cap maintenance	=	$ 8500
Annual reporting	=	$ 3000
		$ 20,500

w/ 25% contingency $ 26,000/YR.

Alt 4A

Capital Cost	=	$ 2,131,000
O&M Cost	=	$ 26,000/YR

Alternative 4B

Assumptions:
Same as in 4A, with additional geomembrane

Capital Cost:

From Alt. 4A	=	$ 1,656,700
geomembrane 8.5 × 48405Y × $6/SY	=	247,000
		$ 1,903,700

w/ 25% contingency $ 2,380,000
w/ fencing $ 2,440,000

O&M Cost:
Same as in 4A $ 26,000/YR

Alt. 4B

Capital Cost	=	$ 2,444,000
O&M Cost	=	$ 26,000/YR

Alternative 5A

Assumptions

same as in 4A except treatment

Capital Cost

From 4A = $ 1,656,700
Less Treatment Cost = − 970,000
$ 686,700

w/ 25% Contingency $ 859,000
w/ fees $ 919,000

O&M Cost

same as in 4A = $ 26,000 /yr.

Alt. 5A

Capital Cost	=	$ 919,000
O&M Cost	=	$ 26,000/Yr

Alternative 5B

Assumptions:
same as in 5A, with additional geomembrane

Capital Cost = $ 686,700
GM cost = $ 247,000

$ 933,700

w/ 25% Contingency $ 1,167,000
w/ fees cost $ 1,227,000

O&M Cost
Same as in 5A = $ 26,000 /Yr.

Alt. 5B

Capital Cost	=	$ 1,227,000
O&M Cost	=	$ 26,000/YR

Alternative 6A. Note: Sheet p[illegible] [illegible] was not designed. The cost for Sheet p[illegible] is expected to square off with the additional [illegible] [illegible] cost.

Assumptions

Same as in 4A with interceptor trench

Capital Cost Alt 4A = 1,656,700
interceptor trench = 84,000

1,740,700

w/ 25% Contingency $ 2,176,000
w/ fencing cost $ 2,236,000

O&M Cost
Same as in 4 $ 26,000/Yr.

Alt 6A

Capital Cost	=	$ 2,236,000
O&M Cost	=	$ 26,000/Yr

Alternative 6B

Same as 6A with the addition of GM

Capital Cost
Alt. 6A = $ 1,740,700
GM Cost = 247,000

1,987,700

w/ 25% Contingency $2,485,000
w/ fencing cost $2,545,000

O&M Cost = $ 26,000 Yr.

Alt. 6B

Capital Cost	=	$ 2,545,000
O&M Cost	=	$ 26,000/Yr

Alternative 7A

Assumptions
same as 6A except treatment

Capital Cost
From Alt. 6A = $ 1,740,700
Less treatment cost = - $ 970,000

$ 770,700

w/ 25% contingency $ 964,000
w/ fencing cost $ 1,024,000

O&M Cost = $ 26,000/Yr

Alt. 7A

Capital cost	=	$ 1,024,000
O&M cost	=	$ 26,000/Yr

Alternative 7B

Same as in 7A with addition of GM

Capital Cost
Alt. 7A = $ 770,700
GM cost = $ 247,000

$ 1017,700

w/ 25% contingency $ 1,272,000
w/ fencing cost $ 1,332,000

O&M Cost $ 26,000/Yr

Alt. 7B

Capital Cost	=	$ 1,332,000
O&M Cost	=	$ 26,000/Yr